AD-753 113

NOISE SURVEY, F-105 OVERFLIGHTS, WICHITA MOUNTAINS WILDLIFE REFUGE AND VICINITY, FORT SILL, OKLAHOMA

Alvin R. Frazier

Environmental Health Laboratory
Kelly Air Force Base, Texas

September 1972

TECHNICAL

Report

NOISE SURVEY, F-105 OVERFLIGHTS

WICHITA MOUNTAINS WILDLIFE REFUGE AND VICINITY

Fort Sill OK

Sep 1972

EHL(K) 72-21

USAF ENVIRONMENTAL

HEALTH LABORATORY

KELLY AFB, TEXAS

PRO SALUTE AC INCOLUMITATE

Atch 69²

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*

USAF Environmental Health Laboratory/CC
Kelly AFB TX 78241

2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

Noise Survey, F-105 Overflights, Wichita Mountains Wildlife Refuge and Vicinity, Fort Sill, OK

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

Alvin R. Frazier, Captain, USAF, BSC

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
September 1972	63	

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	EHL(K) 72-21
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT

Approved for public release, distribution unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	USAF Environmental Health Laboratory/CC Kelly AFB TX 78241

13. ABSTRACT

A noise survey quantitated the environmental noise levels which would be produced by F-105 aircraft flights over the Quanah Weapons Range located on Fort Sill, OK. Data were obtained at a nearby Job Corp Center, Camp Boulder located on the adjoining Wichita Mountains Wildlife Refuge and the cities of Cache and Indiahoma. Adverse effects on the environment are predicted to be minimal and serious interference with present or future land uses is not expected. After serious consideration of many factors, the benefits to be gained through the proposed joint use of this existing artillery range outweigh the minimal adverse effects that would develop because of the flyby noise.

Details of illustrations in this document may be better studied on microfiche

I

DD FORM 1 NOV 68 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Noise						
JET AIRCRAFT (F105) FLYBY NOISE						
COMMUNITY NOISE SURVEY						
F-105 NOISE						

II

USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)

UNITED STATES AIR FORCE

KELLY AFB TX 78241

NOISE SURVEY, F-105 OVERFLIGHTS

WICHITA MOUNTAINS WILDLIFE REFUGE AND VICINITY

Fort Sill OK

Sep 1972

EHL(K) 72-21

PREPARED BY:

ALVIN R. FRAZIER, Capt, USAF, BSC
Bioenvironmental Engineer

APPROVED BY:

WALTER W. MELVIN, JR., Col, USAF, MC
Commander

REVIEWED BY:

WILLIAM E. PICKETT, Maj, USAF, BSC
Chief, Bioenvironmental Eng Div

III

ABSTRACT

A noise survey was conducted (27-30 August 1972) to quantitate the environmental noise levels which would be produced by F-105 aircraft flights over the Quanah Weapons Range located on Fort Sill, Oklahoma. Data were obtained at locations identified as points of major interest. These locations were the Job Corp Center and Camp Boulder, located on the adjoining Wichita Mountains Wildlife Refuge and the cities of Cache and Indiahoma. Generally any adverse effects on the environment are predicted to be minimal and serious interference with present or future land uses is not expected. An area of concern is the Job Corp Center where the brief periods of flyover noise may cause classroom distractions or speech intelligibility difficulties. However, if serious problems of this nature should develop at the Job Corp Center, architectural/ engineering solutions to the problem exist. After serious consideration of many factors, the benefits to be gained through the proposed joint use of this existing artillery range outweigh the minimal adverse effects that would develop because of the flyby noise. Hence, from the standpoint of range flyby noise, use of the Quanah Weapons Range for F-105 training is considered environmentally acceptable and approval is recommended.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

I. INTRODUCTION

A. REASON FOR SURVEY: As requested by Headquarters Air Force Reserve (Hq AFRES) and as directed by the Surgeon, Air Force Logistic Command (AFLC), a noise survey was conducted in the Fort Sill, OK area on 29 August 1972. The survey was to quantitate environmental noise levels which would be produced by F-105 aircraft overflights. The flight paths flown during the noise measurements were made to simulate the flyby noise which would be expected if the Quanah Range were to be used for F-105 weaponry training. The survey requirement was explained by Major James B. Link, Director of Operations & Maintenance, DCS/Civil Engineering Headquarters Air Force Reserve, Robins Air Force Base in the cover letter for the candidate environmental statement sent to Hq USAF/PREV. It was stated: "The Quanah Weapons Range is urgently required to be in operation by 15 September 1972, for the 1 July 1972 activation of the 506th and 507th TAC Ftr Gps at Tinker and Carswell Air Force Bases. These units have their aircraft assigned and are presently engaged in all phases of training except weapons. Unless this range is made available on a timely basis, the mission requirements for weapons training will preclude the Reserves from attaining the first readiness goal of C-3 status within 365 days." To facilitate the data collection the Hq AFRES Project Officer for the flyover, Lt Col J. Wade, (Deputy Commander, 507th TF Gp, Tinker AFB OK) arranged for the F-105 overflights and initially identified locations thought to be of major interest from a noise standpoint. USAF Environmental Health Laboratory personnel (Maj Pickett, Capt Frazier, MSgt Scarborough) augmented by personnel from Bioenvironmental Engineering Services, USAF Hospital, Tinker AFB, (Dr. Roy Buchan, Ph.D. and Airman Lloyd Tosh) collected the flyby data. The noise measurements were made at those locations initially identified by Lt Col Wade and mutually agreed upon as points of major interest.

B. BACKGROUND: The Quanah Weapons Range is located on the 94,000 acre Fort Sill Military Reservation (See Tab A). It is in Comanche County in Southwestern Oklahoma. Fort Sill's southern boundary is adjacent to Lawton OK (approx pop 80,000) and the towns of Cache (approx pop 1000) and Indiahoma (approx pop 387). A portion of the southern boundary of the Wichita Mountain Wildlife Refuge (See Tab B) adjoins the Fort Sill Military Reservation, Quanah Weapons Range boundary. Along this southern boundary of the 59,000 acre Refuge is a 3,800 acre buffer strip separating the refuge from the military reservations. The public visiting the wildlife refuge is excluded from the buffer zone as it is used as a safety zone for ordinance. The wildlife refuge is visited by over one million people annually. In 1971, 54,700 visitors camped out for a total of 2.8 million hours. The refuge contains one of the largest (approx 1000 head) buffalo herds in existence. In addition to the buffalo, the refuge area is the intermittent or permanent home of approximately 230 species of birds and some 50 mammal species, including Texas Longhorn Cattle. Big-game animals are restricted to the refuge by approximately 50 miles of fencing. The midcontinent location of the refuge and diversified terrain bring bring both eastern and western bird species as migrants and nesting birds. About

one-half of the refuge is open to the public.[2] Among the refuge's attractions, which can be reached by 50 miles of paved and gravel roads, are 20 lakes, 11 camp and picnic areas, designated swimming beaches, intermittent streams, canyons, mountain peaks and grasslands for hiking.[3]

Also located on the wildlife refuge is the Treasure Lake Job Corps Center. Its buildings are house trailers and pre-fabricated structures. Classes are held in various buildings throughout the day (0800 to 1500 hrs). The camp provides job corp training for approximately 175 personnel.

The existing 15,850 acre Quanah Artillery Range is used by the Army. The Air Force proposes joint utilization. The range has been operational since 1957 and many types of weapons are fired, including Honest John missles. The Fort Sill Staff Judge Advocate's Office indicates that there have been very few formal complaints concerning existing range operations. Reportedly the community relationship and political climates are good in the adjacent towns of Cache and Indiahoma (Tab B). These two communities would be closest to the F-105 flight path which has been proposed. The Air Force Reserve feels use of the range by the 506 and 507 Tactical Fighter Groups is economically and technically desirable. It is stated in the candidate environmental statement that "All existing bombing ranges (excluding Fort Sill) are beyond the operational range of F-105 aircraft without air refueling or staging. The complexities of the F-105 weapons system preclude staging from another base without full on site-maintenance support. TDY for staging purposes would distract from their primary assigned duties and would have a detrimental effect on the achievement of C-3 status within the required 365 day period." It has been proposed that use of the Fort Sill range would only be during the daytime hours 1000 to 1300 hours and 1500 to 1600 hours and, normally, only Tuesday through Saturday of each week. The number of single aircraft passes over the target area if the maximum projected utilization of the range is achieved, would be 248 per day. During use ofthe range, aircraft would be spaced equal distances apart. This would result in aircraft passing a fixed ground location every 30-45 seconds. It was stated during the survey that ordinance delivered during these passes would be limited to 20 mm cannon shells and marking bombs, BDU-33 (25 lbs) and MK 106 (5 lbs) bombs. The ordinance was not delivered during the study and the survey was confined strictly to the effects of aircraft flyby noise from the range. It was stated that the range would not be utilized for supersonic flight and the need for afterburner operation should not develop. The candidate environmental statement assumed that the use of the range for F-105 weapons training could result in an increase of noise levels in and around the range area. The approach flight pattern and ordinance run patterns are such that the Lawton and Fort Sill cantonment area would not be affected (See Tab B). The areas of concern are the cities of Indiahoma, Cache and a portion of the Wildlife Refuge that would be under or adjacent to the flight pattern (including the Job Corp Center). In order to obtain specific noise data, the survey was accomplished. The project officer for the flyover gave the following nominal flight parameters for both the test overflights and normal

operations (if Hq AFRES receives approval for use of the Quanah Range) 5,000 to 10,000 ft above ground level and 350/400 knots over the Camp Boulder area (Wildlife Refuge); 5,000 to 12,000 ft, 300-400 knots over the Job Corp area (Wildlife Refuge) and directly over the target area 100 to 1,000 ft, 450 knots (Quanah Weapons Range). It is anticipated that during runs on the target the aircraft will be spaced 30-45 seconds apart. The candidate environmental statement prepared by Hq AFRES assessed the impact of the F-105 flyby noise as follows: "The noise created by F-105 fighter aircraft will be new to the area and may have minor adverse effects on the two communities of Cache and Indiahoma as well as people visiting the Wildlife Refuge. Little or no effect will be experienced by the wildlife of the area since it is presently used as an artillery range."

II. DISCUSSION OF DATA

Survey data are presented in the appendix. The flyby data shown for Camp Boulder and the Job Corp Center were taken manually as well as recorded on tape. Because of the nature of the survey, field conditions and the limited equipment available flight parameters were not measured from the ground and thus, the data obtained may not be as universally valuable as might be desirable from a purely scientific standpoint. As stated on the data sheet the flight path was nominal and was subjected to considerable variation once the flybys began. No measurements were made of the slant distance to the aircraft nor were the exact altitudes, speed or aircraft configuration known for each aircraft as it passed the measuring points. These factors were entirely under control of the pilots making the over-flights. However, it is believed that during actual range operations the same type of variations would occur. In short, because of many factors, no attempt was made to conduct the measurements under strictly controlled conditions such as is necessary for civil aircraft certification. However, it is felt the data acquired is more than adequate for the purpose at hand, the environmental assessment of such flyover noise on the communities. The data from the octave band analyses presented represent the maximums that are expected to occur during runs over the firing range.

A. CAMP BOULDER: (See data Tabs C, G, H and I)

At Camp Boulder the main concern was for the effects of flyby noise on the buffalo herd and wildlife refuge visitors. Little is available as specific criteria for either situation. However, an attempt will be made to place the available data in perspective. The maximum noise level measured at Camp Boulder was 89 decibles A-weighted (dBA). That level occurred during a flyby of four (4) F-105's flying in formation. On that particular pass the aircraft were in the process of acquiring the target area and were flying inside of the nominal flight path. For this condition the calculated maximum perceived noise level (PNdB) was 99 PNd. During subsequent single F-105 passes the aircraft conformed to the nominal flight path. The maximum noise level measured was 84 dBA; the calculated PNdB 97. The durations

during which the noise levels were above various dBA values are shown in Tables 1 and 2, Tab C. It is difficult to interpret the data because the standard community noise assessment techniques would not be applicable to a game refuge. As far as human exposures are concerned the intensity and duration of the noise per aircraft pass were such that the possible effects are confined only to annoyance and distraction. This is evident when the data is compared to Table 7 which presents proposed standards for non-occupational exposures. The noise appeared to have absolutely no visible effect on the buffalo (which were observed and within 10 yards of where the noise measurements were made). The noise elicited no response such as head movement, leg movement, etc. The buffalo appeared oblivious to the aircraft noise and continued grazing throughout all aircraft passes. In fact, the noise generated by the firing of an Honest John missile (which caused the ground to shake and which sounded like a very loud thunder clap) had no visible effect upon the buffalo herd. Similar results have been reported during observation of various animals exposed to aircraft noise. The following is an excerpt from Reference 11: "Wild deer studied at Eglin Air Force Base showed no apparent response to high level sonic booms. Animals in the London Zoo were observed in 1968 during a short program of sonic booms over London. Except for a small group of young chimpanzees, which showed a tendency toward fright, the reactions of the zoo animals were negligible." Although the above studies involved principally sonic booms, it seems intuitive that if a fright response was appropriate it would likely be evoked by noise of sudden onset (sonic booms) easier than by flyover noise.

B. JOB CORP CENTER: (See data Tabs D, G, H and I)

The Job Corp Center is located on the wildlife refuge at Treasure Lake. Approximately 175 trainees are housed in house trailers and other prefabricated structures. A considerable portion of their day (0800 to 1500 hours) is devoted to classroom type training. The residual or background noise level in the camp area due to normal activities is quite high relative to Camp Boulder. The maximum noise levels measured during single flybys of F-105 aircraft varied between 74 and 84 dBA. Utilizing the noise spectrum which gives the highest dBA reading and nominal noise reduction values (for frame dwellings with windows partly open), an attempt has been made to estimate the maximum sound pressure levels which might exist inside of the structures due to flyby noise (See Tab D3). The outside noise levels and duration were such that hearing loss considerations are not factors. The noise levels and duration for outside noise are such that adverse effects on normal camp activities should be minimal. Inside of the structures during some aircraft passes, with the windows partly open, the Preferred Speech Interference level (PSIL) may become objectionable. The PSIL calculated from the estimated maximum inside noise levels (windows partly open) was 59 dB. Such a PSIL may be interpreted subjectively as moderately noisy to noisy and some disruption of classroom activities may be expected. It is expected that speech (with listener facing the speaker) should be satisfactorily understood up to a distance of approximately 6 feet

between the speaker and listener if the speaker uses a communicating voice. It should be pointed out that this would probably represent the "worst case." The periods of objectional PSIL's should last only a few seconds during each aircraft pass. Because of repetition, the brief periods of objectionable PSIL's may become annoying during maximum utilization of the range. As a comparison, power lawn mowers cutting grass around the various buildings would be expected to cause the same range of PSIL's. A considerable reduction in the PSIL (improvement) would be expected if the windows and doors were to be kept closed during F-105 overflights.

C. INDIAHOMA: (See data Tabs E, G. H and I)

Noise levels measured at Indiahoma were much less severe in terms of duration and intensity than noise levels measured at the Job Corp Center or Camp Boulder. Noise levels due to the F-105 flybys were little different (except by spectral distribution) from those generated by traffic noise. The psychological and sociological significance of the noise, if any, would probably be due to the visibility of the aircraft and the duration of a given noise level. The reported good relations between the Fort Sill Military Reservation and the community would be expected to further reduce the perceptual impact of the noise. The community presumably has not registered any concerted unfavorable reaction to the noise from artillery firing, including Honest John missiles (an Honest John missile fired subsequent to the survey registered 96 dBC at Indiahoma). Again, as at the other locations, hearing loss from the flyover noise is not a danger to the exposed population (Tab G). In respect to community noise levels the data categorizes the location as no worse than "Discretionary, Normally Acceptable" when compared to the U.S. Department of Housing and Urban Development (HUD) Interim Standards published in HUD Circular 1390.2, 9/1/71.

D. CACHE: (See data Tabs F, G and I)

As would be expected, flyover noise levels at Cache were the lowest. Thus, the environmental impact of flyover noise at Cache would be even less than that at Indiahoma. The flyover noise levels measured during the survey were from 67-72 dBA at Cache. The noise levels generated by the flybys were no greater than those generated by routine activities within the area. Using the HUD interim standards, Cache would be conservatively classified "Discretionary, Normally Acceptable."

E. NOISE EXPOSURE FORECAST (NEF) AND COMMUNITY NOISE EQUIVALENT LEVEL (CNEL) - CAMP BOULDER, JOB CORP CENTER, AND INDIAHOMA:

1. Estimated Noise Exposure Forecast (NEF) values were calculated for Camp Boulder, the Job Corp Center and Indiahoma based on maximum flyover conditions (248 single F-105 passes during daytime only). The assumptions made are given in Tab H. The 2 dB tone correction estimation for

F-105 aircraft is based on past experience. While the NEF values calculated are not exact it is felt that they are a good estimation of the true values.

2. The Community Noise Equivalent Levels (CNEL) for Camp Boulder, the Job Corp Center and Indiahoma were calculated by the procedure in Reference 12. Again, maximum flyover conditions were used to depict the worst case. The CNEL was calculated by an estimating procedure outlined in Tab 1 of the report.

3. Both the NEF and CNEL are designed for estimating community response and as such do not apply in the case of Camp Boulder and the Job Corp Center. The Job Corp Center being different in several respects from a typical residential community. However, they were calculated to assist in putting all measurements in perspective. The NEF and CNEL for actual communities, however, give directly applicable data and are discussed below.

4. The NEF and CNEL were also estimated for Indiahoma (see data Tabs H, I and J). As a residential community, both measures of predicted community response apply directly. The estimated NEF value was 27 and the estimated CNEL value was 59. An NEF of 27 suggests that some noise complaints are possible and noise may interfere with some activities. Similarly, a CNEL of 59 suggests that responses may range from no reaction (although the noise is noticeable) to sporadic complaints. It should be emphasized that both measures (CNEL 59 and NEF 27) are at the extreme low end of the rating scales (toward no reaction). Hence, some complaints are possible (especially in the instance of an isolated home perhaps nearer to the flight path). But, in view of factors such as no nighttime flying activity, good community relations, etc. no serious formal complaints would be expected.

5. Neither the NEF nor CNEL were calculated for Cache. It was felt that the data was insufficient to allow a good estimation. However, all indicators such as distance away from flight path, measured dBA levels, residual noise levels in the community, etc., suggest that the NEF and CNEL for Cache would be considerably less than the Indiahoma values. This means that no complaints would be expected from residents of Cache.

6. There are, on the wildlife refuge, some homes occupied by ten families of refuge employees. No measurements were made at the homesites. However, because of distance relationships it is believed that the noise levels obtained during the F-105 overflights would be similar to those measured at Indiahoma. Hence, it would be expected that the same community rating values (NEF 27, CNEL 59) would be valid estimates for this housing area.

III. CONCLUSION AND RECOMMENDATIONS

It is evident that the use of the Quanah Range by F-105 aircraft will introduce a new source of noise into the areas surrounding the flight path and degrade the environment to some extent. The questions that must be answered are whether or not the new noise levels which will exist on an intermittent basis are such that barring or restricting the F-105 overflights would be justified. Therefore, the physiological and sociological effects on humans, the effects on animals and the seriousness of environmental degradation must all be considered in relation to the benefits to be obtained from joint use of the range. The data acquired during the survey when compared with information available in the literature show that the physiological effects on humans would be minimal. There is no danger of hazardous nonoccupational noise exposure. The data are quite clear in this respect and sufficient safety margins exist to allow for daily exposures to sources other than aircraft noise.

Concern might exist at first glance because of the perceived annoyance indicators such as PNdB and dBA claculated or measured at the Job Corp Center and Camp Boulder. However, the noise levels, the intermittent nature of the noise, the time of day of occurrence of the noise, as well as the expected attitudes of the people at those locations (non-landowners, employees, trainees and visitors, etc.) are considered to be favorable enough to minimize any adverse impact. Neither area is a typical residential community. Occasionally a wildlife refuge visitor may be annoyed when aircraft noise interferes with conversation. To some extent that probably occurs now such as when the artillery range is in use. At the Job Corp Center brief parts of conversation or lectures may be interrupted. Noise levels in the classrooms would probably be no higher than those existing when gas powered lawn mowers are used in the vicinity. For relief the Job Corp Center may have to keep the windows and doors to its classrooms closed.

The potential effects of the noise on refuge animals would seem to be minimal. Information gleaned from the literature also suggests that; as far as visible effects on animals, there were none noted during the observation of the buffalo herd (see attached letter, observation of buffalo herd). Thus, it is felt that effects on the buffalo herd should be minimal and not a major factor in the decision regarding use of the range.

If any community were to be adversely affected by the flyby noise it would likely be Indiahoma. However, the noise data categorizes the location as no worse than "Discretionary, Normally Acceptable" when compared to the U.S. Department of Housing and Urban Development (HUD) Interim Standard published in HUD Circular 1390.2, 9/1/71. The Noise Exposure Forecast (NEF) and Community Noise Equivalent levels were estimated at 27 and 59 respectively. This suggests some complaints are possible and the noise may interfere with some activities (no community reaction to a few sporadic complaints). It sould be emphasized that both measures (CNEL 59 and NEF 27) are at the

extreme low end of the rating scales (toward no reaction). Hence some complaints are possible (especially in the instance of an isolated home perhaps nearer to the flight path). But in view of factors such as no nighttime flying activity, good community relations, etc. no serious formal complaints would be expected. At Cache the impact of the noise on the community would be even less.

Land use and possible environmental degradation is more difficult to put in perspective. Reference 6 (FAA Report No. 70-9 Noise Exposure Forecasts: Evolution, Evaluation, Extensions and Land Use Interpretation) lists under "Land Use Compatibility Guides," noise sensitivity codes of 3-5 for land uses that would be comparable to normal uses of the wildlife refuge. A sensitivity code of 3 to 5 is comparable to an approximate Noise Exposure Forecast (NEF) value of 40 to 55. Code 3 sensitivity is equivalent to park type uses and code 4 is for livestock farming, animal breeding, etc. Code 4 is comparable to NEF 45; code 5 is comparable to NEF 50-55. The estimated NEF values at both Camp Boulder and the Job Corp Center approximate NEF 40. Considering all factors (social, economic, political, etc.), these NEF values infer no serious degradation of land use compatibility.

In consideration of all the above factors the conclusion presented in the candidate environmental statement is accepted as being valid except that it does not consider the Job Corp Center. The conclusion reads: "The noise created by F-105 fighter aircraft will be new to the area and may have minor adverse effects on the people of the two communities of Cache and Indiahoma as well as people visiting the wildlife refuge. Little or no effect will be experienced by the wildlife of the area since it is presently used as an artillery range." It should be added that some adverse effects on the residents of the Job Corp Center may be expected. However, it appears that the benefits to be gained from joint use of the existing range outweigh any adverse effects, which are expected to be minimal and further diminished by favorable community attitudes. Hence, from the standpoint of range flyby noise, use of the Quanah artillery range is considered environmentally acceptable.

IV. PERSONS CONTACTED:

a. Maj Gen John W. Hoff, Commander, Central Air Force Reserve Region

b. Col Neal W. Harris, Deputy Installation Commander, Ft Sill OK

c. Col Claude Lawson, Commander, 506 TF Gp, Carswell AFB TX

d. Col Andrew J. Ritchey, Senior Air Force Representative, Ft Sill OK

e. Col John E. Taylor, Jr., Commander, 507 TF Gp, Tinker AFB OK

f. Lt Col Jim Wade, Deputy Commander, 507 TF Gp, Tinker AFB OK

g. Mr. Julian Howard, Director, Wichita Wildlife Refuge

h. Mr. Jerry K. Brash, Environmental Protection Agency, Region 6, Dallas TX

i. Mr. Dale McHand, Oklahoma State Dept of Health, Div of Occupational Health

j. Mr. Vern Justice, Air Force Reserve, Civil Eng, Robins AFB GA

V. PERSONS ATTENDING LUNCHEON BRIEFING

THE
UNITED STATES AIR FORCE RESERVE
WELCOMES

FT SILL, OKLA

Maj Gen Roderick Wetherill	Commanding General
Brig Gen Robert S. Koch	Assistant Commandant
Colonel Tom Perkins	Chief of Staff
Colonel Neal W. Harris	Deputy Installation Comdr
Colonel J. R. Burks	Director, Plans & Training
Colonel Andrew J. Ritchey	AF Representative
Lt Col A. L. Henderson	Range Officer
Lt Col Vince Keefe	Information Officer
Major Ted Smith	AF Representative

CIVILIAN DIGNITARIES

Mr. Julian Howard	Director Wichita Wild Life
Mr. Rex Paul Taylor	Mayor, Cache, Okla
Mr. A. B. Moore	President, Cache Chamber of Commerce
Mr. Don Whitaker	Mayor, Lawton, Okla
Mr. Everett Haney	Lawton Chamber of Commerce
Mr. Evan G. Jones	President, Lawton Chamber of Commerce
Mr. T. D. Nicolas	Chairman, Military Affairs, Lawton Chamber of Commerce
Mr. Tom Gordon	Mayor, Indiahoma, Okla
Mr. Jim McCoy	Director, Job Corps Camp

ENVIRONMENTAL PROTECTION AGENCY

Mr. Gary Mannering	Oklahoma State Health Dept
Mr. Dale McHard	Oklahoma State Health Dept
Mr. Jerry K. Brasch	Region 6, Dallas
Mr. John Gonzales	Region 6, Dallas

AIR FORCE

Major William Pickett	Kelly AFB, TX
Captain Alvin Frazier	Kelly AFB, TX
MSgt Robert Scarborough	Kelly AFB, TX

AIR FORCE RESERVE

Mr. Vern Justice	Civil Engineering

CENTRAL REGION HEADQUARTERS, ELLINGTON AFB, TX

Maj Gen John W. Hoff	Commander
Mr. Don Reynolds	Information Officer
Colonel R. J. Boyle	Director of Operations
Colonel I. G. Norman	IG

TINKER/CARSWELL AFB

Colonel Claude Lawson	506th TFGp Commander
Colonel John E. Taylor, Jr.	507th TFGp Commander
Lt Col Jim Wade	507th TFGp Dep Commander

VI. PERSONS CONDUCTING SURVEY:

The Quanah Weapons Range noise survey was conducted by Major William E. Pickett, Captain Alvin R. Frazier and MSgt Robert J. Scarborough of the Bioenvironmental Engineering Division of the USAF Environmental Health Laboratory, Kelly AFB TX. Environmental Health Laboratory personnel were augmented by Roy Buchanan, Ph.D. and Airman Lloyd Tosh, Bioenvironmental Engineering personnel assigned to the USAF Hospital, Tinker AFB OK.

VII. EQUIPMENT USED:

a. Octave Band Analyzers, Type 1558BP, Serial Numbers 694,536, 1815 and 2346, mfg by the General Radio Co.

b. Sound Level Meters, Type 1565-A, Serial Numbers 04151 and 02857, mfg by the General Radio Co.

c. Tape Recorder, Nagra IV D, Serial Number 3531.004 marketed by Stephen Kudelski Co.

d. Tape Recorder, Model 1925, Serial Number 0942193, mfg by the General Radio Co.

e. Sound Level Calibrators, Type 1562-A, Serial Numbers 2579, 180, 2822 and 2371, mfg by the General Radio Co.

f. Microphones, Type 1560 P5 and P6, Serial Numbers 240, 4047, 638 and 994, mfg by the General Radio Co.

g. Graphic Level Recorder, Type 1521A, Serial Number 536, mfg by General Radio Co.

h. Assorted accessories, cables, windscreens, microphone tripod, etc.

VIII. REFERENCES:

1. Candidate Environmental Statement, Quanah Air-to-Ground Gunnery Range, prepared by Hq Air Force Reserve, Robins AFB GA.

2. United States Department of the Interior, Fish and Wildlife Service Publication RL-307-R.

3. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife Publication RL-45, January 1972.

4. Fundamentals of Noise: Measurement, Rating Schemes, and Standards, December 31, 1971, U. S. Environmental Protection Agency, Washington DC 20460, Publication NTID 300.15.

5. Technical Report 550-003-03H Aircraft Noise Evaluation, September 1968 (FAA Report No. FAA-NO-68-34), Department of Transportation, Federal Aviation Administration, Office of Noise Abatement, Washington DC 20590.

6. Noise Exposure Forecasts: Evolution, Evaluation, Extensions and Land Use Interpretations, FAA Report FAA-NO-70-9, August 1970, Prepared for Department of Transportation, Federal Aviation Administration, Office of Noise Abatement.

7. Land Use Planning With Respect to Aircraft Noise, AFM 86-5, 1 October 1964.

8. Noise Reduction, Leo L. Beranek, McGraw-Hill Book Company, 1960.

9. Handbook of Noise Measurement, by Arnold P. G. Peterson and Ervin E. Grass, Jr., Seventh Edition, General Radio Co.

10. U. S. Department of Housing and Urban Development Circular 1390.2, HUD, Washington DC, 1971.

11. Noise Facts Digest, U. S. Environmental Protection Agency, Washington DC 20450, pg 70, excerpt 02-016.

12. Community Noise, U. S. Environmental Protection Agency, Report No. NTID 300.3, 31 December 1971.

13. Effects Of Noise on Wildlife And Other Animals, U. S. Environmental Protection Agency publication NTID 300.5, December 31, 1971.

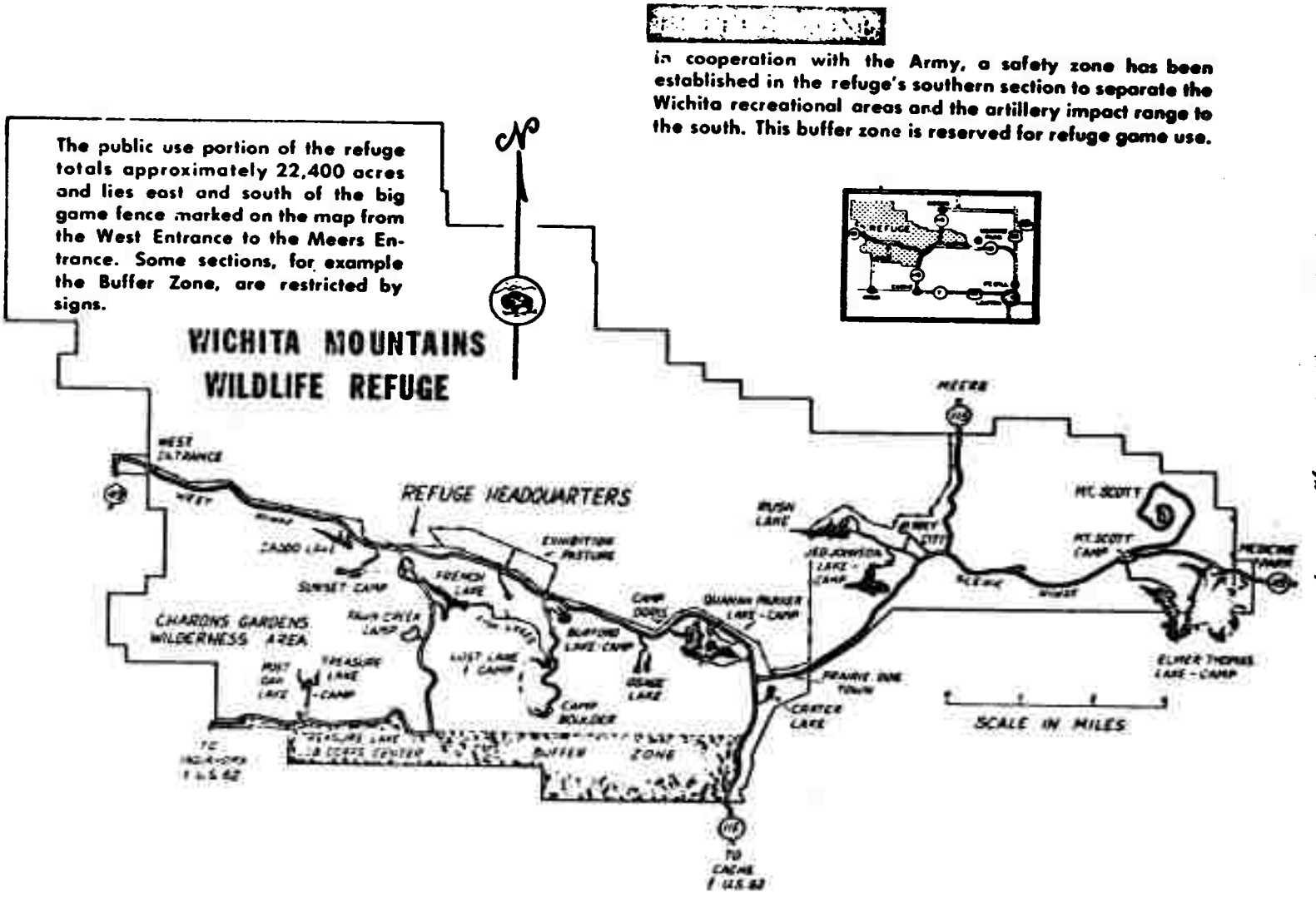


FIGURE 1

TAB A

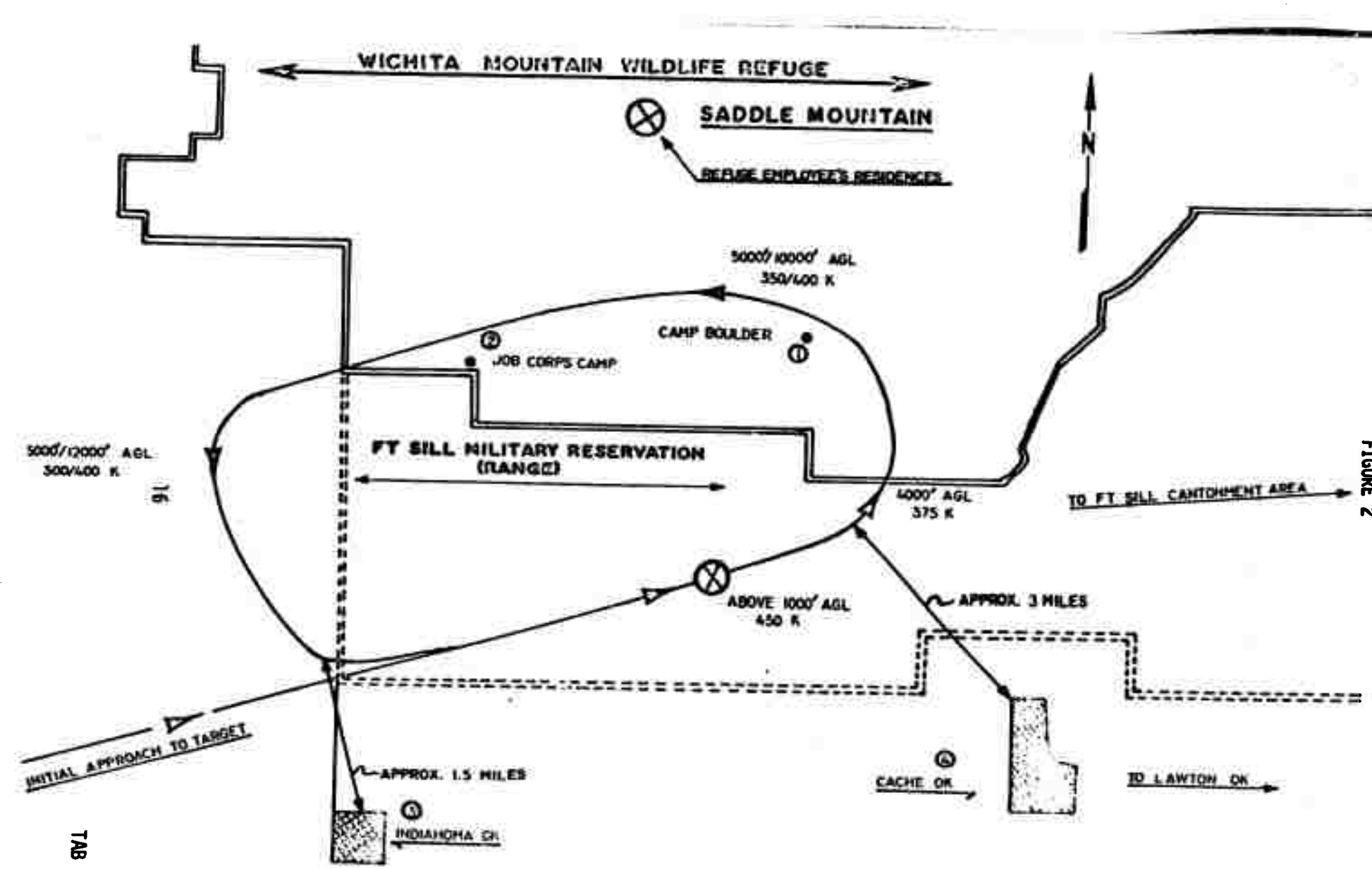


FIGURE 2

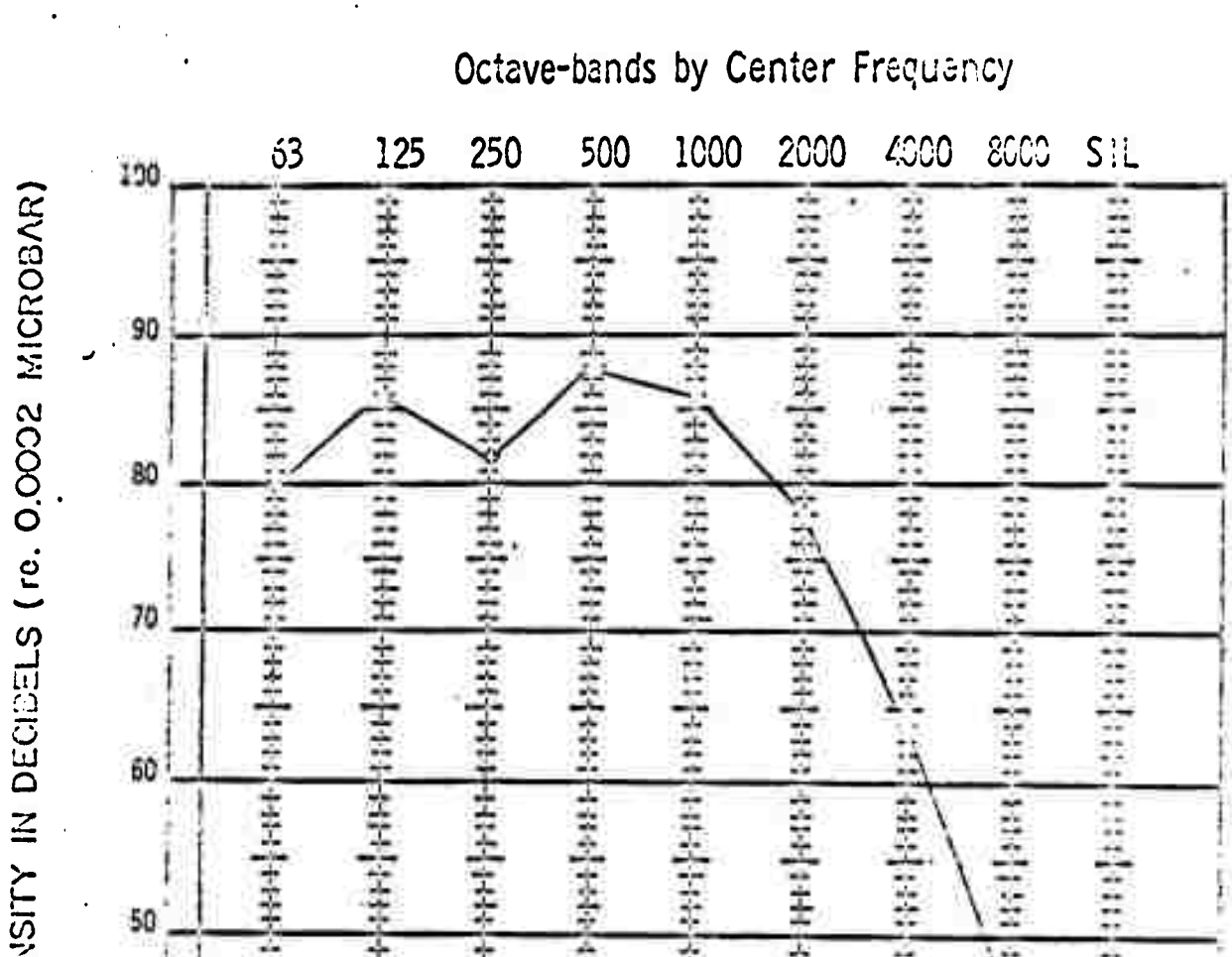
16

TAB B

QUANAH WEAPONS RANGE AND VICINITY

FIGURE 3

OCTAVE BAND ANALYSIS OF TAPE RECORDED FLY-BY
OF FOUR F-105D AIRCRAFT*



LOCATION: Site Nr 1, Camp Boulder
EQUIPMENT USED: Tape Recorder, Octave Band Analyzer, Microphone, Windscreen, Calibrator and Sound Level Meter

*It is believed that on this pass the aircraft were to the inside (farther from the observer) of the nominal flight path.

TABLE 1
NOISE LEVEL DATA COLLECTED AT SITE NR 1, CAMP BOULDER

Octave Band Center Freq (Hertz)	Flight of 4 F-105D A/C: Decibels (dB) Re: 20 uN/M^2	Background Noise Level (Residual): Decibels (dB) Re: 20uN/M^2
OASPL*	91	45-50
8000	46	<44
4000	64	<44
2000	78	<44
1000	86	<44
500	88	<44
250	82	<44
125	86	<44
63	80	<44
dBA	89	<44
PNdB	99	

*OASPL - Overall Sound Pressure Level

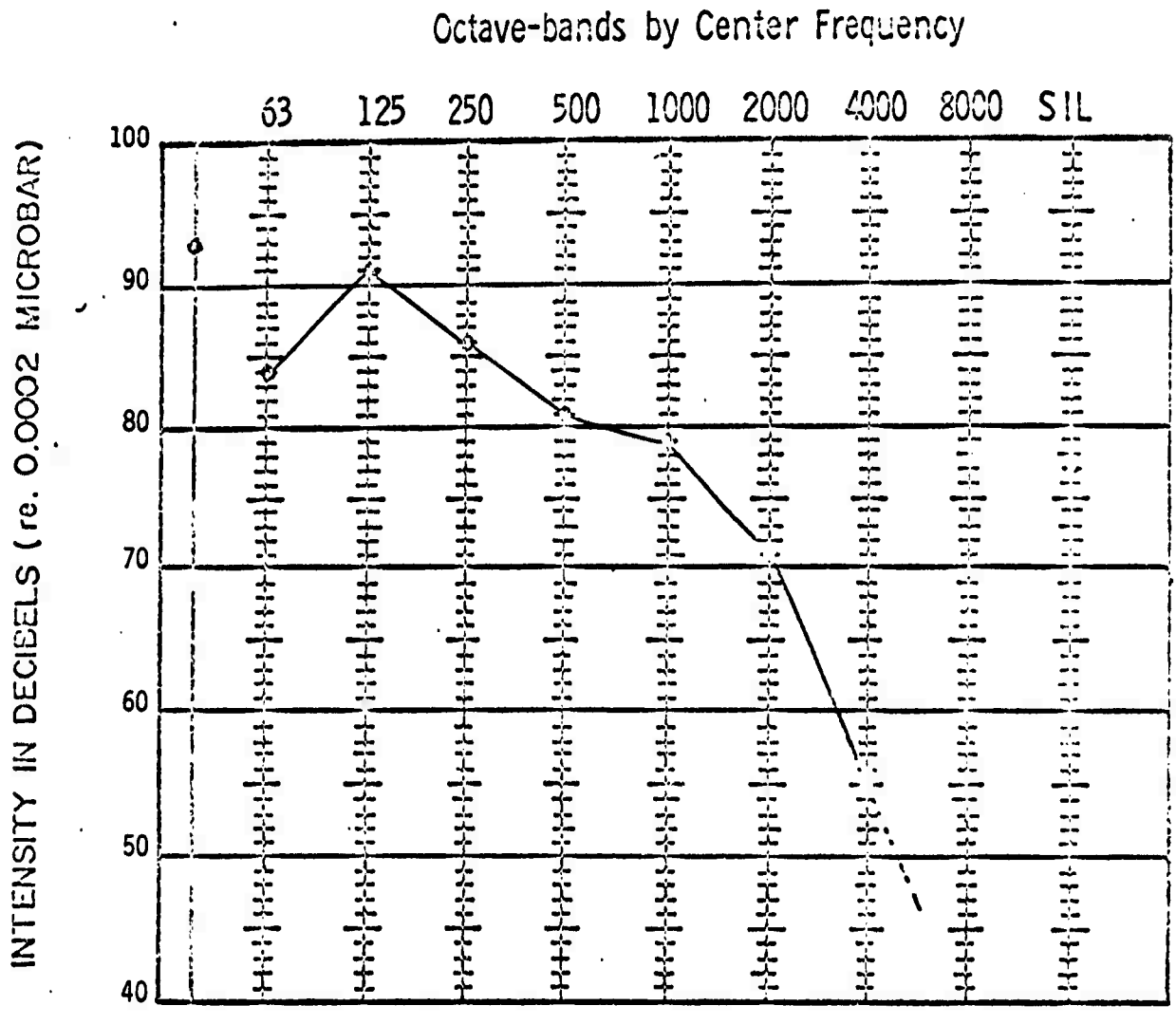
Duration of Noise and Level During Pass of Four F-105's (Formation):

Level Greater Than (dBA Re:20 uN/M^2)	Duration (time in seconds)**
55	76
65	44
75	25
80	22
85	7

**Obtained by analyzing tape data by graphic level recorder.

FIGURE 4

OCTAVE BAND ANALYSIS OF TAPE RECORDED FLY-BY
OF A SINGLE F-105D AIRCRAFT*



LOCATION: Site Nr 1, Camp Boulder
EQUIPMENT USED: Tape Recorder, Octave Band Analyzer, Microphone, Calibrator Sound Level Meter and Windscreen

*It is believed that on this pass of a single F-105 that the aircraft was very near the nominal flight path.

TABLE 2

NOISE LEVEL DATA COLLECTED AT SITE NR 1, CAMP BOULDER

Flight of 1 F-105D A/C		Background Noise Level (Residual)	
Octave Band Center Freq (Hertz)	Decibels Re:20 uN/M^2	Octave Band Center Freq (Hertz)	Decibels Re:20 uN/M^2
OASPL	93	OASPL	45-50
8000	44	8000	<44
4000	55	4000	<44
2000	71	2000	<44
1000	79	1000	<44
500	81	500	<44
250	86	250	<44
125	91	125	<44
63	84	63	<44
dBA	84	dBA	<44
PNdB	97		

Duration of Noise and Level During Pass of Single F-105

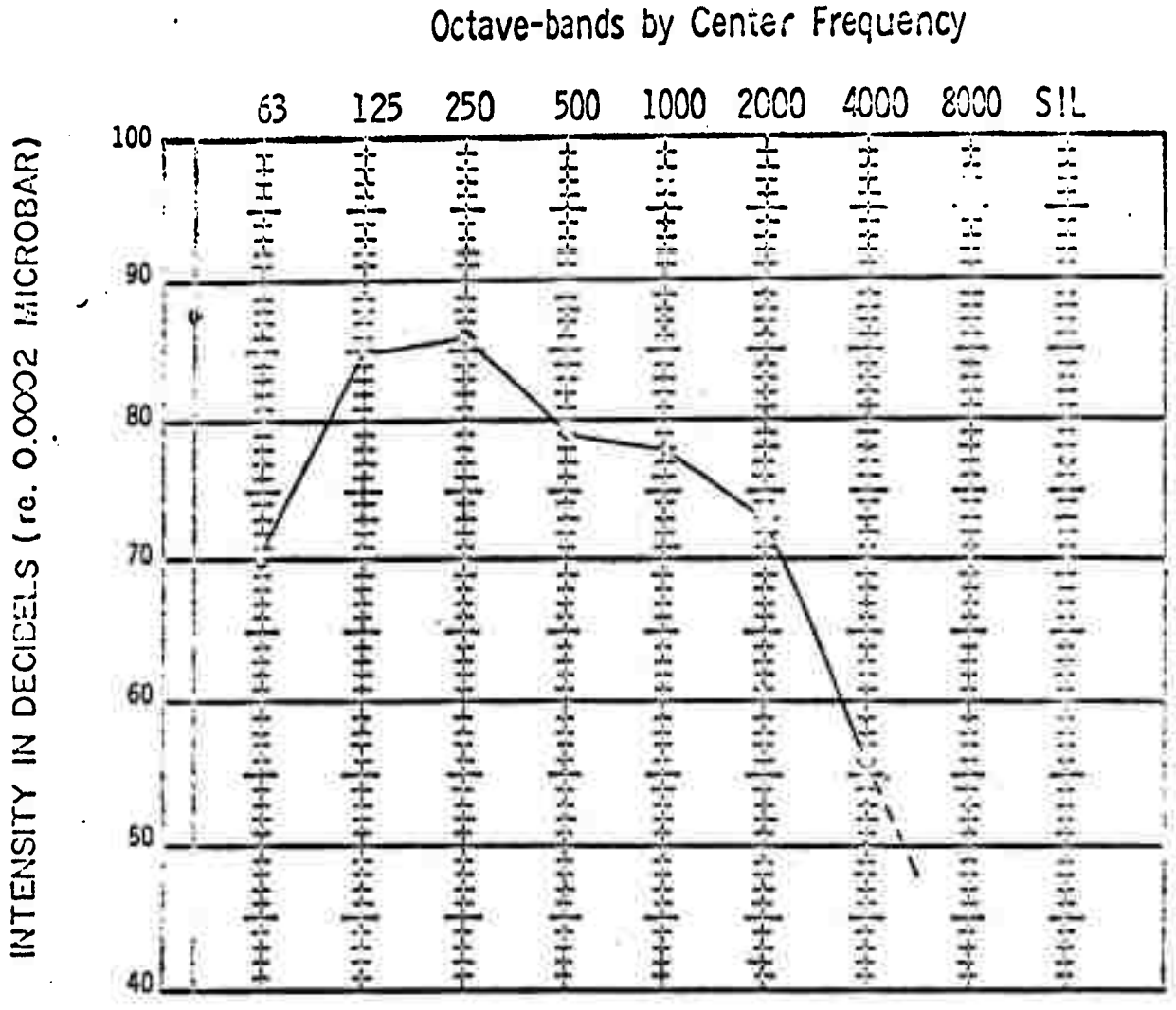
Level Greater Than (dBA Re:20 uN/M^2)	Duration* (time in seconds)
55	81
65	70
75	35
80	6
85	0

*By Graphic Level Recorder

Range of Subsequent Single F-105 Passes (dBA)	80-83
Range of OASPL During Subsequent Passes of Single F-105	87-91 dBC

FIGURE 5

OCTAVE BAND ANALYSIS OF TAPE RECORDED FLY-BY
OF A SINGLE F-105D AIRCRAFT



LOCATION: Site Nr 2, Job Corp Camp
EQUIPMENT USED: Tape Recorder, Octave Band Analyzer, Microphone, Calibrator and Sound Level Meter

TABLE 3

NOISE LEVEL DATA COLLECTED AT SITE NR 2, JOB CORP CAMP

Flight of 1 F-105D A/C

Octave Band Center Freq (Hertz)	Decibels Re:20 uN/M^2
OASPL	88
8000	<44
4000	56
2000	73
1000	78
500	79
250	86
125	85
63	70
dBA	84
PNdB	94

Background Noise Level (Residual)

Octave Band Center Freq (hertz)	Decibels Re:20 uN/M^2
OASPL	69
8000	<44
4000	<44
2000	<44
1000	<44
500	58
250	63
125	61
63	57
dBA	58

*Duration of Noise and Level During Pass of Single F-105

Level Greater Than (dBA Re:20 uN/M^2)	Duration (time in seconds)
85	0
80	12
75	43

*Other data not shown because of relatively high background noise level caused by a power lawn motor being used in the area.

dBA During Subsequent Aircraft Passes

Pass Nr	3	4	5	6	7	8	9
dBA Re:20 µN/M^2	78	74	78	79	77	83	75

TABLE 4

ESTIMATION OF NOISE LEVEL AND PREFERRED SPEECH INTERFERENCE LEVEL (PSIL) INSIDE OF TRAILER AT JOB CORP CENTER

Octave Band Center Freq (Hertz)	Noise Levels in General Area Re:20 uN/M2	Nominal Reduction by Trailers With Windows Partly Open	Predicted Approximate Levels Inside of Trailers, Windows Partly Open
8000	<44	-20	<44
4000	56	-20	36
2000	73	-20	53
1000	78	-18	60
500	79	-15	64
250	86	-13	73
125	85	-12	73
63	70	-12	58

PSIL = $\frac{53 + 60 + 64}{3}$ = 59* approximately equivalent to 67 dBA

*This PSIL may be interpreted as moderately noisy to noisy with speech understood satisfactorily up to distance of approximately 6 feet between listener and speaker with speaker speaking in a communicating voice.

The PSIL is calculated by taking the arithmetic average of the noise levels in the 500, 1000, and 2000 Hertz preferred center frequency bands. The PSIL may also be referred to occasionally simply as the Speech Interference Level (SIL).

TABLE 5

DAYTIME NOISE LEVEL DATA COLLECTED AT SITE NR 3, INDIAHOMA, OK
(levels in dB Re: 20 $\mu N/M^2$)

Duration of Noise and Level During Pass of Four F-105's (formation):

Level Greater than (dBA)	Duration (time in seconds)
65	84 approx.
75	18
80	8
85	0

Typical Noise Values at Site:

Occurrence	Range in dBA
Background (Residual)	<62
Trucks Passing	67-78
Single F-105 Fly-bys	67-79
Honest John Missile Fired	96 dBC

Location: Indiahoma OK

Equipment Used: Octave Band Analyzer, Microphone, Windscreen, Calibrator and Graphic Level Recorder

Date: 29 August 1972 (1230 to 1600 hours)

TAB E

TABLE 6

DAYTIME NOISE LEVEL DATA COLLECTED AT SITE NR 4, CACHE, OK

Typical Noise Values at Site:

Occurrence	Range in dBA
Background (Residual)	51-56
Train Whistle	63
Bulldozer, 25 yds	61-76
Semi-Trailer (Truck) on Roadway	77
Car Passing	69
Flt of Four F-105's	74
Single F-105 Passes	67-72
Honest John Missile Fired	89

Location: Cache, OK

Equipment Used: Sound Level Meter and Calibrator

Date: 29 August 1972 (1230 to 1600 hours)

TABLE 7

TABLE OF SUGGESTED NOISE LIMITS FOR NON-OCCUPATIONAL NOISE EXPOSURE[4]

(Suggested to provide protection of essentially all persons at all audiometric frequencies*)

Maximum Suggested Non-Occupational Exposure		Comparable Data For Camp Boulder, Job Corp Center and Indiahoma based Maximum Exposure (248 Passes per day) To Single Aircraft Flyby Noise**			
Sound Level dBA	Daily Exposure Time	Camp Boulder	Job Corp Center	Indiahoma	Cache±
70	16-24 hour				-
75	8	2.4 hours	2.9 hours	1.2 hours	-
80	4	25 minutes	50 minutes	33 minutes	-
85	2	0	0	0	-
90	1				
95	30 minutes				
100	15				
105	8				
110	4				
115	2				

4. See Reference 4.

*Choen, A., Anticaglia, J., and Jones, H. H., Pociocusis, " ... hearing loss from non-occupational noise exposure, Sound and Vibration," 4 (11), 12-20 (November 1970).

**Considers maximum noise level and maximum number of aircraft passes over range.

± Duration data was not available for Cache, but sound pressure level measurements (dBA) suggests that the affect at Cache would substantially less than that at Indiahoma.

ESTIMATED NOISE EXPOSURE FORECASTS (NEF)

METHOD OF APPROXIMATION:

a. $NEF = 10\log_{10} 10^{\frac{Lepn}{10}} + 10\log_{10}N - 88$*

b. Where:

1. Lepn = Effective Perceived Noise Level (EPNL).

2. N = Number of daytime events.

c. Where EPNL was estimated as follows:

1. dBA max + 13 approximates Perceived Noise Level (PNL).

2. Tone correction approximates 2 dB For F-105.

3. PNL + 2 approximates Tone Corrected Perceived Noise Level (PNLTM).

4. Duration Correction (D) approximates $D = 10\log_{10} (d/T)$ where:

D = duration correction

d = duration at 10 dB down points

T = Normalizing time of 15 seconds

d. EPNL = PNLTM + D**

* See Reference 6
** See Reference 5

TAB H

ESTIMATED NEF CALCULATED FOR CAMP BOULDER AND THE JOB CORP CENTER*

1. Camp Boulder Estimation of NEF for Single F-105 Flyby

PNL = 84 dBA + 13 = 97 PNdB

PNLTM = 97 + 2 = 99 PNdB

$D = 10\log\left(\frac{35}{19}\right) \approx 4$ PNdB

EPNL = 99 + 4 = 103 EPNdB

$NEF = 10\log_{10} 10^{\frac{103}{10}} + 10\log_{10} 248 - 88$

$= 103 + 24 - 88 = 39$

NEF (Camp Boulder) = 39

2. Job Corp Center Estimation of NEF for Single F-105 Flyby

PNL = 84 + 13 = 97 PNdB

PNLTM = 97 + 2 = 99 PNdB

$D = 10 \log\left(\frac{43}{15}\right) \approx 5$

EPNL = 99 + 5 = 104 EPNdB

$NEF = 10 \log_{10} 10^{\frac{104}{10}} + 10 \log_{10} 248 - 88$

$+ 104 + 24 - 88 = 40$

NEF (Job Corp) = 40

3. Indiahoma Estimation of NEF for Single F-105 Flyby

PNL = 75 + 13 = 88 PNdB

PNLTM = 88 + 2 = 90 PNdB

$D = 10 \log\left(\frac{18}{15}\right) \approx 1$

EPNL = 90 + 1 = 91 EPNdB

$NEF = 10 \log_{10} 10^{\frac{91}{10}} + 10 \log_{10} 248 - 88$

$91 + 24 - 88 \approx 27$

*Estimates of NEF for maximum flyover conditions; 248 daytime passes of single F-105 aircraft.

APPROXIMATE COMMUNITY NOISE EQUIVALENT LEVEL (CNEL) (ESTIMATOR OF CNEL WHERE ONE TYPE OF AIRCRAFT AND ONE FLIGHT PATH DOMINATES)*

$CNEL = SENEL + 10 \log N_c - 49.4$ dB

Where: $SENEL = NL_{max} + 10 \log_{10}{}^{t}$ ea (dB)

NL_{max} = Max dBA level

$10 \log_{10}{}^{t}$ ea = effective time duration in seconds

= approx 1/2 of the 10 dB down duration

Nc = total number of flights during 0700 to 1900

SENEL = single noise exposure level (dB)

SENEL = energy mean value of SENEL for each single event

1. Camp Boulder:

$CNEL = N_{L_{max}} + 10 \log_{10}{}^{t} + 10 \log_{10} NC - 49.4$ dB

$= 84 + 10 \log_{10} 18 + 10 \log_{10} 248 - 49.4$

$= 84 + 12.5 + 24 - 49.4 = 71$

2. Job Corp Center:

$CNEL = 84 + 10 \log_{10} 22 + 10 \log_{10} 248 - 49.4$

$= 84 + 13.4 + 24 - 49.4 = 72$

3. Indiahoma:

$CNEL = 75 + 10 \log_{10} 9 + 10 \log_{10} 248 - 49.4$

$75 + 9.5 + 24 - 49.4 = 59$

*See Reference 12

TAB I

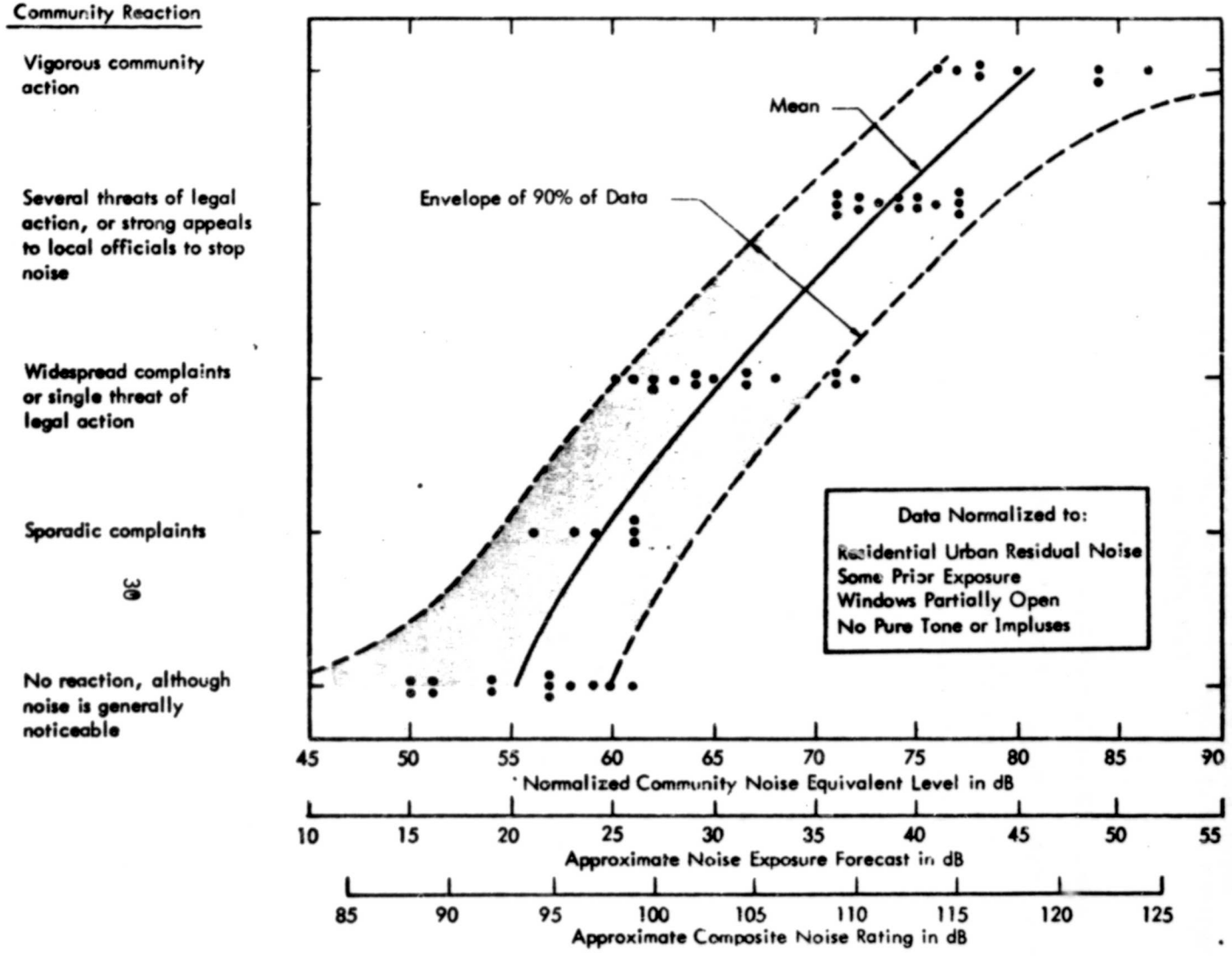


Figure 24. Community Reaction to Intrusive Noises of Many Types as a Function of the Normalized Community Noise Equivalent Level

TAB J

TAKEN FROM "COMMUNITY NOISE" U. S. EPA PUBLICATION NTID 300.3, December 31, 1971

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

WICHITA MOUNTAINS WILDLIFE REFUGE
CACHE, OKLAHOMA 73527

October 3, 1972

Environmental Health Laboratory
Kelly AFB, Texas 78241

Attn: Capt. Frazier

This will respond to your phone request for information on effects of aircraft noise on wildlife during exposure to military aircraft on 29 August. Observations were made by members of the refuge staff at four locations as follows: Timber Hill (Coord. 416/302) Boulder Camp (397/295) Post Oak Hill, south boundary (384/269) Quanah Parker Lake (329/410). No observations were made of animals located directly under the flight paths of the aircraft. The closest flight path was estimated to be about 1200' feet south of Camp Boulder.

Reactions of animals observed are as follows: Timber Hill, no distinctive reaction observed in buffalo or longhorn; Boulder Camp, no reaction reaction attributed to aircraft noise; Post Oak Hill, no animals in view; Quanah Parker Lake, no apparent reaction by buffalo. No other animals such as deer, elk or small game were observed, during the flights.

The effects of direct overhead flights of jet aircraft on buffalo and longhorn are not known, particularly during periods of the rut and parturition.

Sincerely,

Roger D. Johnson
Refuge Manager

Don E. Whitaker
Mayor

City of Newton
Newton, Oklahoma 73501

September 7, 1972

Lt. Col. Jim Wade
Commander
507th TFGp
Tinker Air Force Base, Oklahoma

Dear Col. Wade:

I would like to take this opportunity to thank you for inviting me to the briefing on the "Quanah Parker" program and the plans for conversion of Air Force Reserve units to the F105 aircraft as part of the Department of Defense total force concept. I apologize that due to a previous commitment I was unable to attend the demonstration of F105 gunnery training which followed the luncheon. However, it has been related to me that this demonstration was most informative.

I do not foresee any adverse local civilian impact in the use of the Quanah range for the purpose as outlined in the briefing.

Very truly yours,

Don E. Whitaker

DON E. WHITAKER
Mayor

dew/sc

LAWTON
CHAMBER
OF COMMERCE

LAWTON, OKLAHOMA POST OFFICE BOX 1367 73501

August 31, 1972

Major General John Hoff
CC Central Region Headquarters
Ellington Air Force Base
Houston, Texas 77030

Dear General Hoff:

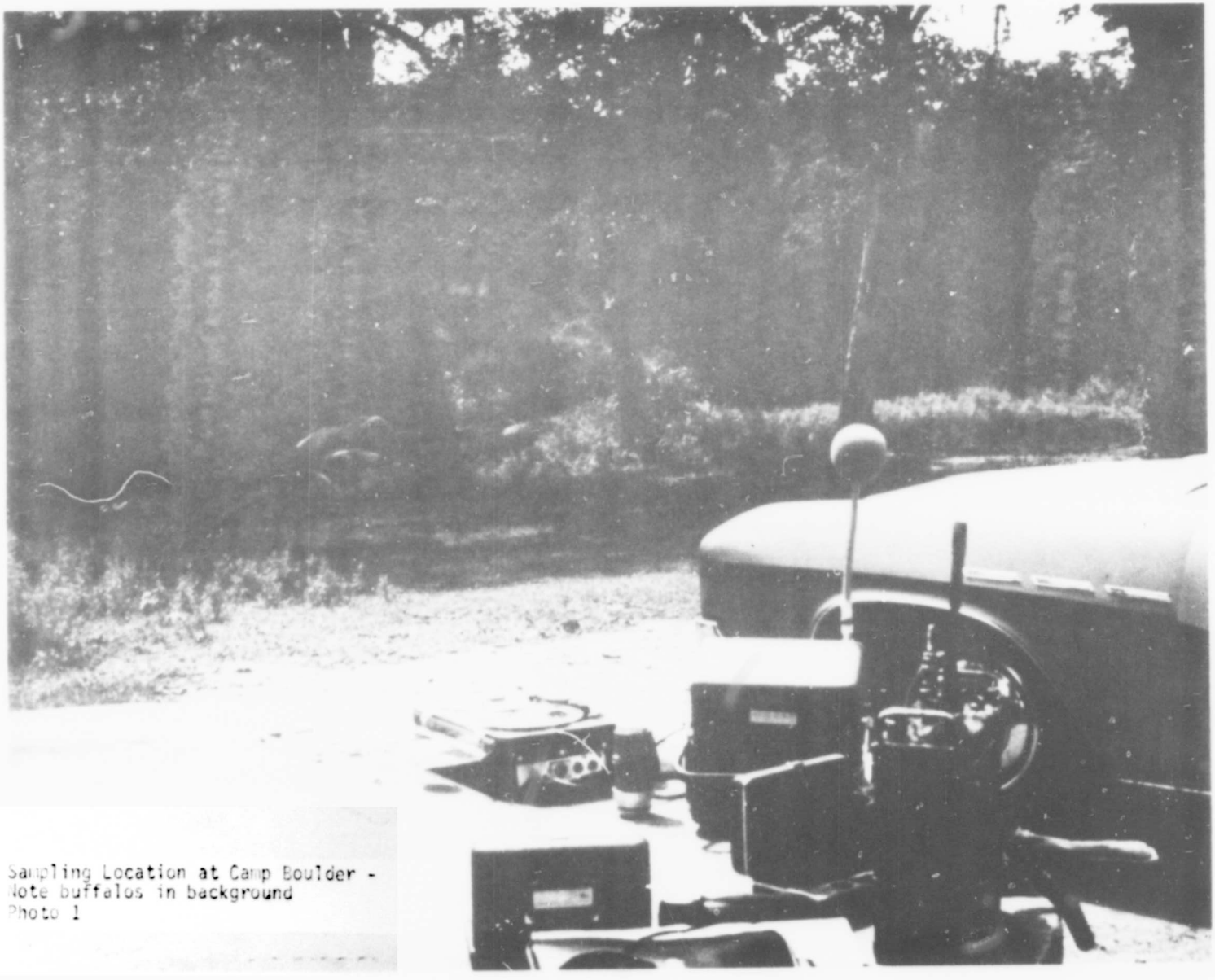
Thank you for a very fine briefing on the "Quanah Parker" program and the plans for conversion of Air Force Reserve units to the F105 aircraft as part of the Department of Defense total force concept. The demonstration of F105 gunnery training which followed over the Quanah range at Fort Sill was most interesting and informative.

The Lawton Chamber of Commerce highly favors the training of the citizen soldier in this weapons system and sees no adverse local civilian impact in the use of the Quanah range for this purpose.

Sincerely yours,

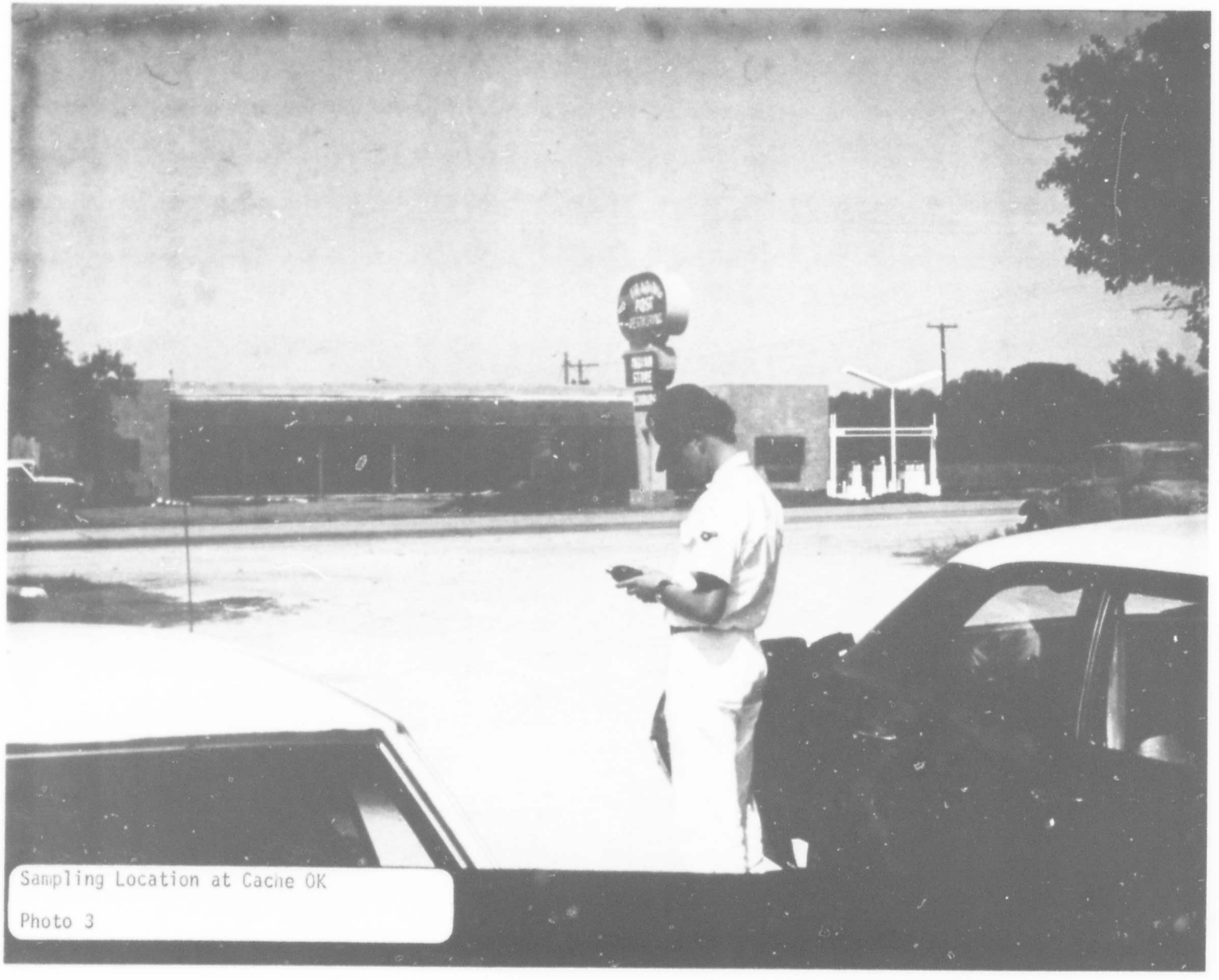
E. G. "Cap" Jones
President

EGJ:ib



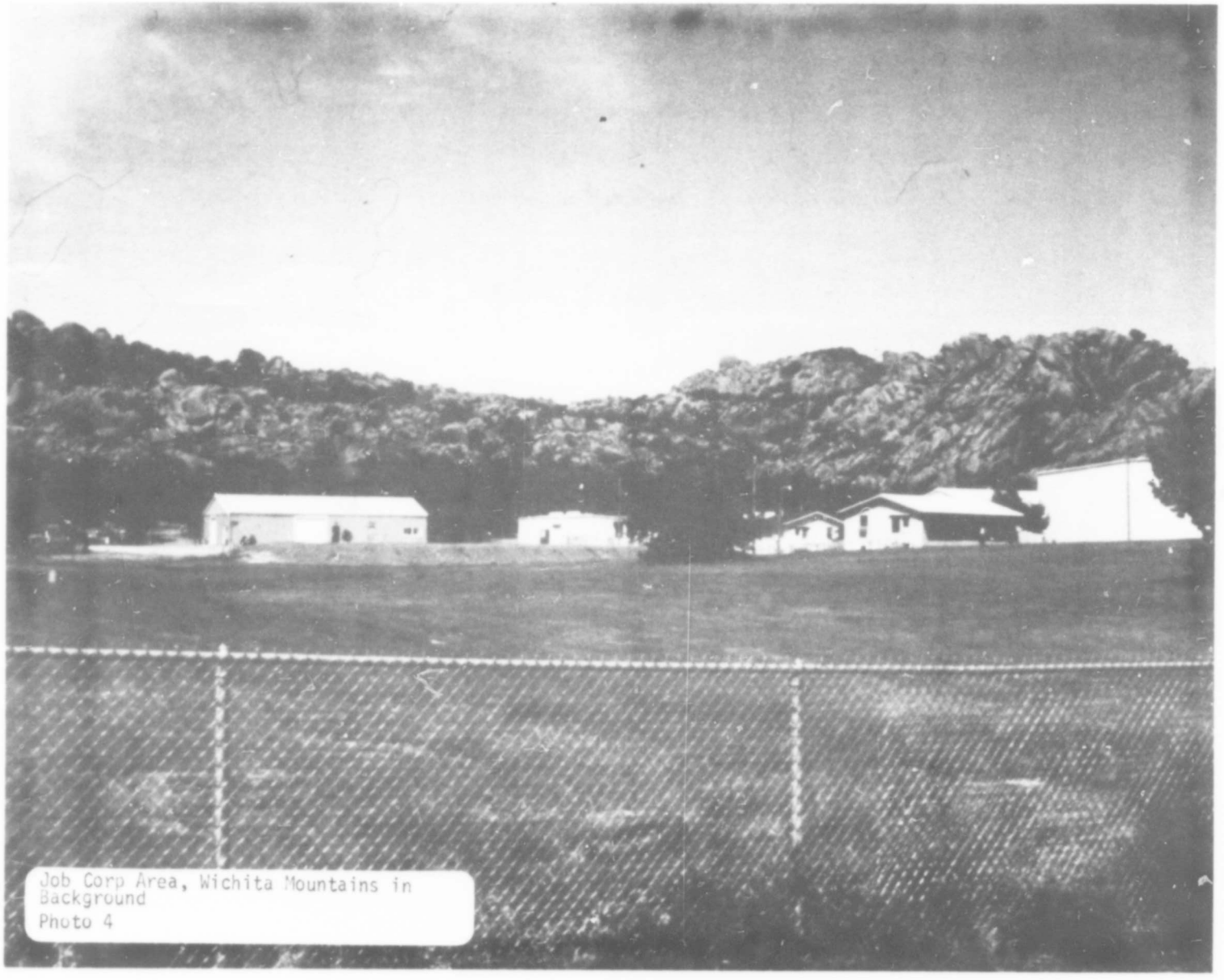
Sampling Location at Camp Boulder -
Note buffalos in background
Photo 1

Buffalos Near Sampling Location at
Camp Boulder
Photo 2



Sampling Location at Cache OK

Photo 3



Job Corp Area, Wichita Mountains in Background
Photo 4

Sampling Location at Indiahoma OK

Photo 5

GLOSSARY*

The following explanations of terms are provided to assist the reader in understanding some terms used in this publication:

A-WEIGHTED SOUND LEVEL -- The ear does not respond equally to frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dB. A popular method of indicating the units, dBA, is used in this Digest. The A-weighted sound level is also called the noise level. Sound level meters have an A-weighting network for measuring A-weighted sound level.

ABSORPTION -- Absorption is a property of materials that reduces the amount of sound energy reflected. Thus, the introduction of an "absorbent" into the surfaces of a room will reduce the sound pressure level in that room by virtue of the fact that sound energy striking the room surfaces will not be totally reflected. It should be mentioned that this is an entirely different process from that of transmission loss through a material, which determines how much sound gets into the room via the walls, ceiling, and floor. The effect of absorption merely reduces the resultant sound level in the room produced by energy which has already entered the room.

ABSORPTION COEFFICIENT -- A measure of sound-absorbing ability of a surface. This coefficient is defined as the fraction of incident sound energy absorbed or otherwise not reflected by the surface. Unless otherwise specified, a diffuse sound field is assumed. The values of sound-absorption coefficient usually range from about 0.01 for marble slate to almost 1.0 for long absorbing wedges such as are used in anechoic chambers.

*This Glossary was taken from "Noise Facts Digest" a U. S. Environmental Protection Agency publication.

ACCELEROMETER (ACCELERATION PICKUP) -- An electroacoustic transducer that responds to the acceleration of the surface to which the transducer is attached, and delivers essentially equivalent electric waves.

ACOUSTICAL POWER -- See sound power.

ACOUSTICS -- (1) The science of sound, including the generation, transmission, and effects of sound waves, both audible and inaudible. (2) The physical qualities of a room or other enclosure(such as size, shape, amount of sound absorption, and amount of noise) which determine the audibility and perception of speech and music.

AIRBORNE SOUND -- Sound that reaches the point of interest by propagation through air.

AIR FLOW RESISTANCE -- See flow resistance.

AMBIENT NOISE LEVEL -- The ambient noise level follows the usage of the word "ambient" throughout the environmental sciences (except acoustics). That is, the ambient noise level is that level which exists at any instant, regardless of source.

ANALYSIS -- The analysis of a noise generally refers to the examination composition of the noise in its various frequency bands, such as octaves or third-octaves bands.

ANECHOIC ROOM -- An anechoic room is one whose boundaries have been designed (with acoustically absorbent materials) to absorb nearly all the sound incident on its boundaries, thereby affording a test room essentially free from reflected sound.

ANTINODE (LOOP) -- A point, line, or surface in a standing wave where the vibration or sound pressure has maximum amplitude.

ARTICULATION INDEX (AI) -- A numerically calculated measure of the intelligibility of transmitted or processed speech. It takes into account the limitations of the transmission path and the background noise. The articulation index can range in magnitude between 0 and 1.0. If the AI is less than 0.1, speech intelligibility is generally low. If it is above 0.6, speech intelligibility is generally high.

AUDIO FREQUENCY -- The frequency of oscillation of an audible sine-wave of sound; any frequency between 20 and 20,000 Hz. See also frequency.

AURAL -- Of or pertaining to the ear or hearing.

AUDIOGRAM -- A graph showing hearing loss as a function of frequency.

AUDIOMETER -- An instrument for measuring hearing sensitivity of hearing loss.

BACKGROUND NOISE -- The total of all noise in a system or situation, independent of the presence of the desired signal. In acoustical measurements, strictly speaking, the term "background noise" means electrical noise in the measurement system. However, in popular usage the term "background noise" is also used with the same meaning as "residual noise."

BAFFLE -- A baffle is a shielding structure or series of partitions used to increase the effective length of the external transmission path between two points in an acoustic system. For example, baffles may be used in sound traps (as in air conditioning ducts) or in automotive mufflers to decrease the sound transmitted while affording a path for air flow.

BAND -- A segment of the frequency spectrum.

BAND CENTER FREQUENCY -- The designated (geometric) mean frequency of a band of noise or other signal. For example, 1000 Hz is the band center frequency for the octave band that extends from 707 Hz to 1414 Hz, or for the third-octave band that extends from 891 Hz to 1123 Hz.

BAND PRESSURE (OR POWER) LEVEL -- The pressure (or power) level for the sound contained within a specified frequency band. The band may be specified either by its lower and upper cut-off frequencies, or by its geometric center frequency. The width of the band is often indicated by a prefatory modifier; e.g., octave band, third-octave band, 10-Hz band.

BOOM CARPET -- The area on the ground underneath an aircraft flying at supersonic speeds that is hit by a sonic boom of specified magnitude.

BROADBAND NOISE -- Noise with components over a wide range of frequencies.

C-WEIGHTED SOUND LEVEL (dBC) -- A quantity, in decibels, read from a standard sound-level meter that is switched to the weighting network labeled "C". The C-weighting network weights the frequencies between 70 Hz and 4000 Hz uniformly, but below and above these limits frequencies are slightly discriminated against. Generally, C-weighted measurements are essentially the same as overall sound-pressure levels, which require no discrimination at any frequency.

COINCIDENCE EFFECT -- The coincidence effect occurs when the wavelength of the bending wave in a panel coincides with the length of an incident sound wave at the angle at which it strikes the panel. At any particular frequency, this effect can occur only if the wave in air is traveling at a particular angle with respect to the surface of the panel. Under this condition a high degree of coupling is achieved between the bending wave in the panel and the sound in the air. When the coincidence effect occurs, the transmission loss for the panel is greatly reduced. See also critical frequency.

COMMUNITY NOISE EQUIVALENT LEVEL -- Community Noise Equivalent Level (CNEL) is a scale which takes account of all the A-weighted acoustic energy received at a point, from all noise events causing noise levels above some prescribed value. Weighting factors are included which place greater importance upon noise events occurring during the evening hours (7:00 p. m. to 10:00 p. m.) and even greater importance upon noise events at night (10:00 p. m. to 6:00 a. m.).

COMPOSITE NOISE RATING -- Composite noise rating (CNR) is a scale which takes account of the totality of all aircraft operations at an airport in quantifying the total aircraft noise environment. It was the earliest method for evaluating compatible land use around airports and is still in wide use by the Department of Defense in predicting noise environments around military airfields.

COMPOSITE NOISE RATING -- (Cont'd)

Basically, to calculate a CNR value one begins with a measure of the maximum noise magnitude from each aircraft flyby and adds weighting factors which sum the cumulative effect of all flights. The scale used to describe individual noise events is perceived noise level (in PNdB); the term accounting for number of flights is $10 \log_{10} N$ (where N is the number of flight operations), and each night operation counts as much as 10 daytime operations. Very approximately, the noise exposure level at a point expressed in the CNR scale will be numerically 35-37 dB higher than if expressed in the CNEL scale.

CONTINUOUS SOUND SPECTRUM -- A continuous sound spectrum is comprised of components which are continuously distributed over a frequency region.

CRITERION -- A criterion, in Federal environmental usage, is a statement of the cause and effect relationship between a given level of pollutant and specific effects on human life.

CRITICAL FREQUENCY -- The critical frequency is the lowest frequency at which the coincidence effect can occur. At this frequency the coincidence angle is 90°, that is, the sound wave is traveling parallel to the surface of the panel. Below this frequency, the wavelength in air is greater than the bending wavelength in the panel.

CUTOFF FREQUENCIES -- The frequencies that mark the ends of a band, or at which the characteristics of a filter change from pass to no-pass.

CYLINDRICAL DIVERGENCE -- Cylindrical divergence is the condition of propagation of cylindrical waves that accounts for the regular decrease in intensity of a cylindrical wave at progressively greater distances from the source. Under this condition the sound-pressure level decreases 3 decibels with each doubling of distance from the source. See also spherical divergence.

CYLINDRICAL WAVE -- A cylindrical wave is a wave in which the surfaces of constant phase are coaxial cylinders. A line of closely spaced sound sources radiating into an open space produces a free sound field of cylindrical waves. See also cylindrical divergence.

CYCLES PER SECOND -- A measure of frequency numerically equivalent to Hertz.

DAMAGE RISK CRITERION -- A statement of noise levels (including frequency, duration, intermittancy, and other factors) above which permanent hearing loss of at least a specified amount is likely to be sustained by a person (to a given degree of probability). See also hearing loss, criterion.

DAMPING -- The dissipation of energy with time or distance. The term is generally applied to the attenuation of sound in a structure owing to the internal sound-dissipative properties of the structure or owing to the addition of sound-dissipative materials.

DECIBEL -- The decibel (abbreviated "dB") is a measure, on a logarithmic scale, of the magnitude of a particular quantity (such as sound pressure, sound power, intensity, etc.) with respect to a standard reference value. (0.0002 microbars for sound pressure and 10^{-12} watt for sound power).

DIFFUSE SOUND FIELD -- The presence of many reflected waves (echoes) in a room (or auditorium) having a very small amount of sound absorption, arising from repeated reflections of sound in various directions. In a diffuse field, the sound pressure level, averaged over time, is everywhere the same and the flow of sound energy is equally probable in all directions.

DIRECTIVITY INDEX -- In a given direction from a sound source, the difference in decibels between (a) the sound-pressure level produced by the source in that direction, and (b) the space-average sound-pressure level of that source, measured at the same distance.

DIRECTIVITY PATTERN -- The directivity pattern of a source of sound is the hypothetical surface in space over which the sound pressure levels produced by the source are constant. See also directivity index.

DOPPLER EFFECT (DOPPLER SHIFT) -- The apparent upward shift in frequency of a sound as a noise source approaches the listener (or vice versa), and the apparent downward shift when the noise source recedes. The classic example is the change in pitch of a railroad whistle as the locomotive approaches and passes by.

DUCT LINING OR WRAPPING -- Usually a sheet of porous material placed on the inner or outer wall(s) of a duct to introduce sound attenuation and heat insulation. It is often used in air conditioning systems. Linings are more effective in attenuating sound that travels inside along the length of a duct, while wrappings are more effective in preventing sound from being radiated from the duct sidewalls into surrounding spaces.

EFFECTIVE PERCEIVED NOISE LEVEL (EPNL) -- A physical measure designed to estimate the effective "noisiness" of a single noise event, usually an aircraft fly-over; it is derived from instantaneous Perceived Noise Level (PNL) values by applying corrections for pure tones and for the duration of the noise.

ELECTROACOUSTICS -- The science and technology of transforming sound waves into currents in electrical circuits (and vice versa), by means of microphones, loudspeakers, and electronic amplifiers and filters.

FAR FIELD -- Consider any sound source in free space. At a sufficient distance from the source, the sound pressure level obeys the inverse-square law (the sound pressure decreases 6 dB with each doubling of distance from the source). Also, the sound particle velocity is in phase with the sound pressure. This region is called the far field of the sound source. Regions closer to the source, where these two conditions do not hold, constitute the near field. In an enclosure, as opposed to free space, there can also sometimes be a far field region if there is not so much reflected sound that the near field and the reverberant field merge. See also reverberant field.

FILTER -- A device that transmits certain frequency components of the signal (sound or electrical) incident upon it, and rejects other frequency components of the incident signal.

FLOW RESISTANCE -- The flow resistance of a porous material is one of the most important quantities determining the sound absorbing characteristics of the material. Flow resistance is a ratio of the pressure differential across a sample of the porous material to the air velocity through it.

FOOTPRINT (NOISE) -- The shape and size of the geographical pattern of noise impact that an aircraft makes on the areas near an airport while landing or taking off.

FREE SOUND FIELD (FREE FIELD) -- A sound field in which the effects of obstacles or boundaries on sound propagated in that field are negligible.

FREQUENCY -- The number of times per second that the sine-wave of sound repeats itself, or that the sine-wave of a vibrating object repeats itself. Now expressed in Hertz(Hz), formerly in cycles per second (cps).

FUNCTION -- A quantity which varies as a result of variations of another quantity.

FUNDAMENTAL FREQUENCY -- The frequency with which a periodic function reproduces itself, sometimes called the first harmonic. (see also harmonic).

GAUSSIAN DISTRIBUTION (Or NORMAL DISTRIBUTION) -- A term used in statistics to describe the extent and frequency of deviations or errors. The outstanding characteristics are a tendency to a maximum number of occurrences at or near the center or mean point, the progressive decrease of frequency of occurrence with distance from the center, and the symmetry of distribution on either side of the center. In respect of random noise, each fluctuation of amplitude is an occurrence, whether above or below the mean level; the peak value of each fluctuation is the error and the distribution of errors with time is Gaussian.

GRADIENT -- A variation of the local speed of sound with height above ground or other measure of distance causing refraction of sound. It is most commonly caused by rising or falling temperature with altitude or by differences in wind speed.

HARMONIC -- A sinusoidal (pure-tone) component whose frequency is a whole-number multiple of the fundamental frequency of the wave. If a component has a frequency twice that of the fundamental it is called the second harmonic.

HEARING DISABILITY -- An actual or presumed inability, due to hearing impairment, to remain employed at full wages.

HEARING HANDICAP -- The disadvantage imposed by a hearing impairment sufficient to affect one's efficiency in the situation of everyday living.

HEARING IMPAIRMENT -- A deviation or change for the worse in either hearing structure or function, usually outside the normal range; see hearing loss.

HEARING LOSS -- At a specified frequency, an amount, in decibels, by which the threshold of audibility for that ear exceeds a certain specified audiometric threshold, that is to say, the amount by which a person's hearing is worse than some selected norm. The norm may be the threshold established at some earlier time for that ear, or the average threshold for some large population, or the threshold selected by some standards body for audiometric measurements.

HEARING LOSS FOR SPEECH -- The difference in decibels between the speech levels at which the "average normal" ear and a defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50%.

HERTZ -- Unit of measurement of frequency, numerically equal to cycles per second.

IMPACT -- (1) An impact is a single collision of one mass in motion with a second mass which may be either in motion or at rest. (2) Impact is a word used to express the extent or severity of an environmental problem; e. g., the number of persons exposed to a given noise environment.

IMPACT INSULATION CLASS (IIC) -- A single-figure rating which is intended to permit the comparison of the impact sound insulating merits of floor-ceiling assemblies in terms of a reference contour.

IMPACT SOUND -- The sound arising from the impact of a solid object on an interior surface (wall, floor, or ceiling) of a building. Typical sources are footsteps, dropped objects, etc.

INFRASONIC -- Of a frequency below the audio frequency range.

INVERSE-SQUARE LAW -- The inverse-square law describes that acoustic situation where the mean-square pressure changes in inverse proportion to the square of the distance from the source. Under this condition the sound-pressure level decreases 6 decibels with each doubling of distance from the source. See also spherical divergence.

ISOLATION -- See vibration isolator.

JET NOISE -- Noise produced by the exhaust of a jet into its surrounding atmosphere. It is generally associated with the turbulence generated along the interface between the jet stream and the atmosphere.

L_{10} LEVEL -- The sound level exceeded 10% of the time. Corresponds to peaks of noise in the time history of environmental noise in a particular setting.

L_{50} LEVEL -- The sound level exceeded 50% of the time. Corresponds to the average level of noise in a particular setting, over time.

L_{90} LEVEL -- The sound level exceeded 90% of the time. Corresponds to the residual noise level.

LEVEL -- The value of a quantity in decibels. The level of an acoustical quantity (sound pressure or sound power), in decibels, is 10 times the logarithm (base 10) of the ratio of the quantity to a reference quantity of the same physical kind.

LINE SPECTRUM -- The spectrum of a sound whose components occur at a number of discrete frequencies.

LIVE ROOM -- One characterized by an unusually small amount of sound absorption. See reverberation room.

LOUDNESS -- The judgment of intensity of a sound by a human being. Loudness depends primarily upon the sound pressure of the stimulus. Over much of the loudness range it takes about a threefold increase in sound pressure (approx. 10 dB) to produce a doubling of loudness.

LOUDNESS LEVEL -- The loudness level of a sound, in phons, is numerically equal to the median sound pressure level, in decibels, relative to 0.0002 microbar, of a free progressive wave of frequency 1000 Hz presented to listeners facing the source, which in a number of trials is judged by the listeners to be equally loud.

MACH NUMBER -- The ratio of a speed of a moving element to the speed of sound in the surrounding medium.

MASKING -- The action of bringing one sound (audible when heard alone) to inaudibility or to unintelligibility by the introduction of another sound. It is most marked when the masked sound is of higher frequency than the masking sound.

MASKING NOISE -- A noise which is intense enough to render inaudible or unintellibilible another sound which is simultaneously present.

MEAN FREE PATH -- The average distance sound travels between successive reflections in a room.

MEDIUM -- A substance carrying a sound wave.

MICRO BAR -- A microbar is a unit of pressure, equal to one dyne per square centimeter.

MICROPHONE -- An electroacoustic transducer that responds to sound waves and delivers essentially equivalent electric waves.

NEAR FIELD -- See far field.

NODE -- A point, line, or surface where a wave has zero amplitude.

NOISE -- Any sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

NOISE CRITERION (NC) CURVES -- Any of several versions (SC, NC, NCA, PNC) of criteria used for rating the acceptability of continuous indoor noise levels, such as produced by air-handling systems.

NOISE EXPOSURE FORECAST -- Noise exposure forecast (NEF) is a scale (analogous to CNEL and CNR) which has been used by the federal government in land use planning guides for use in connection with airports.

In the NEF scale, the basic measure of magnitude for individual noise events is the effective perceived noise level (EPNL), in units of EPNdB. This magnitude measure includes the effect of duration per event. The terms accounting for number of flights and for weighting by time period are the same as in the CNR scale. Very approximately, the noise exposure level at a point expressed in the NEF scale will be numerically about 33 dB lower than if expressed in the CNEL scale.

NOISE INSULATION -- See sound insulation.

NOISE ISOLATION CLASS (NIC) -- A single number rating derived in a prescribed manner from the measured values of noise reduction. It provides an evaluation of the sound isolation between two enclosed spaces that are acoustically connected by one or more paths.

NOISE LEVEL -- See sound level.

NOISE AND NUMBER INDEX (NNI) -- A measure based on Perceived Noise Level, and with weighting factors added to account for the number of noise events, and used (in some European countries) for rating the noise environment near airports.

NOISE POLLUTION LEVEL (L_{NP} or NPL) -- A measure of the total community noise, postulated to be applicable to both traffic noise and aircraft noise. It is computed from the "energy average" of the noise level and the standard deviation of the time-varying noise level.

NOISE REDUCTION (NR) -- The noise reduction between two areas or rooms is the numerical difference, in decibels, of the average sound pressure levels in those areas or rooms. A measurement of "noise reduction" combines the effect of the transmission loss performance of structures separating the two areas or rooms, plus the effect of acoustic absorption present in the receiving room.

NOISE REDUCTION COEFFICIENT (NRC) -- A measure of the acoustical absorption performance of a material, calculated by the averaging its sound absorption coefficients at 250, 500, 1000, and 2000 Hz, expressed to the nearest integral multiple of 0.05.

NORMAL DISTRIBUTION -- See Gaussian distribution.

NOYS -- A unit used in the calculation of perceived noise level.

OCTAVE -- An octave is the interval between two sounds having a basic frequency ratio of two. For example, there are 8 octaves on the keyboard of a standard piano.

OCTAVE BAND -- All of the components, in a sound spectrum, whose frequencies are between two sine wave components separated by an octave.

OCTAVE-BAND SOUND PRESSURE LEVEL -- The integrated sound pressure level of only those sine-wave components in a specified octave band, for a noise or sound having a wide spectrum.

OSCILLATION -- The variation with time, alternately increasing and decreasing, (a) of some feature of an audible sound, such as the sound pressure, or (b) of some feature of a vibrating solid object, such as the displacement of its surface.

PARTIAL NODE -- A partial node is the point, line, or surface in a standing wave system where there is a minimum amplitude differing from zero.

PEAK SOUND PRESSURE -- The maximum instantaneous sound pressure (a) for a transient or impulsive sound of short duration, or (b) in a specified time interval for a sound of long duration.

PERCEIVED NOISE LEVEL (PNL) -- A quantity expressed in decibels that provides a subjective assessment of the perceived "noisiness" of aircraft noise. The units of Perceived Noise Level are Perceived Noise Decibels, PNdB.

PERIOD -- The duration of time it takes for a periodic wave form (like a sine wave) to repeat itself.

PERMANENT THRESHOLD SHIFT (PTS) -- See temporary threshold shift.

PHASE -- For a particular value of the independent variable, the fractional part of a period through which the independent variable has advanced, measured from an arbitrary reference.

PHON -- The unit of measurement for loudness level.
Phon = $40 + \log_2$ sone.

PINK NOISE -- Noise where level decreases with increasing frequency to yield constant energy per octave of band width.

PITCH -- A listener's perception of the frequency of a pure tone; the higher the frequency, the higher the pitch.

PLANE WAVE -- A wave whose wave fronts are parallel and perpendicular to the direction in which the wave is travelling.

PNdB -- See perceived noise level.

PRESBYCUSIS -- The decline in hearing acuity that normally occurs as a person grows older.

PURE TONE -- A sound wave whose waveform is that of a sine-wave.

RANDOM INCIDENCE -- If an object is in a diffuse sound field, the sound waves that comprise the sound field are said to strike the object from all angles of incidence at random. See also Gaussian distribution.

RANDOM NOISE -- An oscillation whose instantaneous magnitude is not specified for any given instant of time. It can be described in a statistical sense by probability distribution functions giving the fraction of the total time that the magnitude of the noise lies within a specified range.

RATE OF DECAY -- Rate of decay is the time rate at which the sound-pressure level (or other stated characteristic, such as a vibration level) decreases at a given point and at a given time after the source is turned off. The commonly used unit is decibels per second.

REFRACTION -- The bending of a sound wave from its original path, either because it is passing from one medium to another or because (in air) of a temperature or wind gradient in the medium.

RESIDUAL NOISE LEVEL -- The term "residual noise" has been adopted to mean the noise which exists at a point as a result of the combination of many distant sources, individually indistinguishable. In statistical terms, it is the level which exists 90 percent of the time. (Acousticians should note it means the same level to which they have customarily applied the term "ambient.") See also background noise.

RESONANCE -- The relatively large amplitude of vibration produced when the frequency of some source of sound or vibration "matches" or synchronizes with the natural frequency of vibration of some object, component, or system.

RESONATOR -- A resonator is a device that resounds or vibrates in sympathy with some source of sound or vibration.

RETROFIT -- The retroactive modification of an existing building or machine. In current usage, the most common application of the word "retrofit" is to the question of modification of existing jet aircraft engines for noise abatement purposes.

REVERBERANT FIELD -- The region in a room where the reflected sound dominates, as opposed to the region close to the noise source where the direct sound dominates.

REVERBERATION -- The persistence of sound in an enclosed space, as a result of multiple reflections, after the sound source has stopped.

REVERBERATION ROOM -- A room having a long reverberation time, especially designed to make the sound field inside it as diffuse (homogeneous) as possible. Also called a live room.

REVERBERATION TIME (RT) -- The reverberation time of a room is the time taken for the sound pressure level (or sound intensity) to decrease to one-millionth (60 dB) of its steady state value when the source of sound energy is suddenly interrupted. It is a measure of the persistence of an impulsive sound in a room and of the amount of acoustical absorption present inside the room.

ROOM CONSTANT -- The room constant is equal to (a) the product of the average absorption coefficient of the room and the total internal area of the room, divided by (b) the quantity one minus the average absorption coefficient.

ROOT-MEAN-SQUARE (RMS) -- The root-mean square value of a quantity that is varying as a function of time is obtained by squaring the function at each instant, obtaining the average of the squared values over the interval of interest, and taking the square root of this average. For a sine wave, multiply the RMS value by $\sqrt{2}$, or about 1.43, to get the peak value of the wave. The RMS value, also called the effective value of the sound pressure, is the best measure of ordinary continuous sound, but the peak value is necessary for assessment of impulse noises.

SHIELDING -- The attenuation of a sound by placing walls, buildings, or other barriers between a sound source and the receiver.

SINE-WAVE -- A sound wave, audible as a pure tone, in which the sound pressure is a sinusoidal function of time.

SONE -- The unit of measurement for loudness. One sone is the loudness of a sound whose level is 40 phons.

SONIC BOOM -- The pressure transient produced at an observing point by a vehicle that is moving past (or over) it faster than the speed of sound.

SOUND -- See acoustics (1).

SOUND ABSORPTION COEFFICIENT -- See absorption coefficient.

SOUND ANALYZER -- A sound analyzer is a device for measuring the band pressure level or pressure-spectrum level of a sound as a function of frequency.

SOUND INSULATION -- (1) The use of structures and materials designed to reduce the transmission of sound from one room or area to another or from the exterior to the interior of a building. (2) The degree by which sound transmission is reduced by means of sound insulating structures and materials.

SOUND LEVEL (NOISE LEVEL) -- The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

SOUND LEVEL METER -- An instrument, comprising a microphone, an amplifier, an output meter, and frequency-weighting networks, that is used for the measurement of noise and sound levels in a specified manner.

SOUND POWER -- Of a source of sound, the total amount of acoustical energy radiated into the atmospheric air per unit time.

SOUND POWER LEVEL -- The level of sound power, averaged over a period of time, the reference being 10^{-12} watts.

SOUND PRESSURE -- (1) The minute fluctuations in atmospheric pressure which accompany the passage of a sound wave; the pressure fluctuations on the tympanic membrane are transmitted to the inner ear and give rise to the sensation of audible sound. (2) For a steady sound, the value of the sound pressure averaged over a period of time. (3) Sound pressure is usually measured (a) in dynes per square centimeter, (dyn/cm^2), or (b) in newtons per square meter (N/m^2). 1 N/m^2 = 10 dyn/cm^2 10^{-5} times the atmospheric pressure.

SOUND PRESSURE LEVEL -- The root-mean-square value of the pressure fluctuations above and below atmospheric pressure due to a sound wave; expressed in decibels re a reference pressure of 0.0002 microbars (2×10^{-5} Newtons per square meter).

SOUND SHADOW -- The acoustical equivalent of a light shadow. A sound shadow is often partial because of diffraction effects.

SOUND TRANSMISSION CLASS (STC) -- The preferred single figure rating system designed to give an estimate of the sound insulation properties of a partition or a rank ordering of a series of partitions. It is intended for use primarily when speech and office noise constitute the principal noise problem.

SOUND TRANSMISSION COEFFICIENT -- The fraction of incident sound energy transmitted through a structural configuration.

SOUND TRANSMISSION LOSS (TRANSMISSION LOSS) (TL) -- A measure of sound insulation provided by a structural configuration. Expressed in decibels, it is 10 times the logarithm to the base 10 of the reciprocal of the sound transmission coefficient of the configuration.

SPACE-AVERAGE SOUND PRESSURE LEVEL -- The space-average sound-pressure level is the sound pressure level averaged over all directions at a constant distance from the source.

SPECTRUM -- Of a sound wave, the description of its resolution into components, each of different frequency and (usually) different amplitude and phase.

SPEECH-INTERFERENCE LEVEL (SIL)* -- A calculated quantity providing a guide to the interfering effect of a noise on reception of speech communication. The speech-interference level is the arithmetic average of the octave-band sound-pressure levels of the interfering noise in the most important part of the speech frequency range. The levels in the three octave-frequency bands centered at 500, 1000, and 2000 Hz are commonly averaged to determine the speech-interference level. Numerically, the magnitudes of aircraft sounds in the Speech-Interference Level scale are approximately 18 to 22 dB less than the same sounds in the Perceived Noise Level scale in PNdB, depending on the spectrum of the sound.

SPEED (VELOCITY) OF SOUND IN AIR -- The speed of sound in air is 344 m/sec or 1128 ft/sec at 78°F.

SPHERICAL DIVERGENCE -- Spherical divergence is the condition of propagation of spherical waves that relates to the regular decrease in intensity of a spherical sound wave at progressively greater distances from the source. Under this condition the sound-pressure level decreases 6 decibels with each doubling of distance from the source. See also cylindrical divergence.

SPHERICAL WAVE -- A sound wave in which the surfaces of constant phase are concentric spheres. A small (point) source radiating into an open space produces a free sound field of spherical waves.

SPL -- See sound pressure level.

STANDARD -- (1) A prescribed method of measuring acoustical quantitites. Standards in this sense are promulgated by professional and scientific societies like ANSI, SAE, ISO, etc., as well as by other groups. (2) In the sense used in Federal environmental statutes, a standard is a specific statement of permitted environmental conditions.

STANDING WAVE -- A periodic sound wave having a fixed distribution in space, the result of interference of traveling sound waves of the same frequency and kind. Such sound waves are characterized by the existence of nodes, or partial nodes, and antinodes that are fixed in space.

*When the preferred frequencies, 500, 1000 and 2000 Hertz are used, the SIL is commonly referred to as the Preferred Speech Interference Level, (PSIL).

STEADY-STATE SOUNDS -- Sounds whose average characteristics remain constant in time. An example of a steady-state sound is an air conditioning unit.

STRUCTUREBORNE SOUND -- Sound that reaches the point of interest, over at least part of its path, by vibration of a solid structure.

SUBHARMONIC -- A sound component of frequency a whole-number of times less than the fundamental frequency of the sounds' complex wave.

TAPPING MACHINE -- A device that produces a standard impulsive noise by letting weights drop a fixed distance onto the floor. Used in tests measuring the isolation from impact noise provided by various floor-ceiling constructions.

TEMPORARY THRESHOLD SHIFT (TTS) -- A temporary impairment of hearing capability as indicated by an increase in the threshold of audibility. By definition, the ear recovers after a given period of time. Sufficient exposures to noise of sufficient intensity, from which the ear never completely recovers, will lead to a permanent threshold shift (PTS), which constitutes hearing loss. See hearing loss, threshold shift, threshold of audibility.

THIRD-OCTAVE BAND -- A frequency band whose cut-off frequencies have a ratio of 2 to the one-third power, which is approximately 1.26. The cut-off frequencies of 891 Hz and 1112 Hz define a third-octave band in common use. See also band center frequency.

THRESHOLD OF AUDIBILITY (THRESHOLD OF DETECTABILITY) -- The minimum sound-pressure level at which a person can hear a specified sound for a specified fraction of trials.

THRESHOLD SHIFT -- An increase in a hearing threshold level that results from exposure to noise.

TONE -- A sound of definite pitch. A pure tone has a sinusoidal wave form.

TRAFFIC NOISE INDEX (TNI) -- A measure of the noise environment created by vehicular traffic on highways; it is computed from measured values of the noise levels exceeded 10 percent and 90 percent of the time.

TRANSMISSION LOSS -- See sound transmission loss.

TRANSDUCER -- A device capable of being actuated by waves from one or more transmission systems or media and supplying related waves to one or more other transmission systems or media. Examples are microphones, accelerometers, and loudspeakers.

TTS -- See temporary threshold shift

ULTRASONIC -- Pertaining to sound frequencies above the audible sound spectrum (in general, higher than 20,000 Hz).

VIBRATION ISOLATOR -- A resilient support for machinery and other equipment that might be a source of vibration, designed to reduce the amount of vibration transmitted to the building structure.

WAVEFORM -- A presentation of some feature of a sound wave, e.g., the sound pressure, as a graph showing the moment-by-moment variation of sound pressure with time.

WAVEFRONT -- An imaginary surface of a sound wave on its way through the atmosphere. At all points on the wavefront, the wave is of equal amplitude and phase.

WAVELENGTH -- For a periodic wave (such as sound in air), the perpendicular distance between analogous points on any two successive waves. The wavelength of sound in air or in water is inversely proportional to the frequency of the sound. Thus the lower the frequency, the longer the wavelength.

WHITE NOISE -- Noise whose energy is uniform over a wide range of frequencies, being analogous in spectrum characteristics to white light. White noise has a "hishing" sound. See also broadband noise.

WRAPPING -- See duct lining or wrapping.

ABBREVIATIONS

AA	Auditory Awakening Threshold
ANZ	Audible Noise Sensitive Warning
AI	Acceptability Index
AI	Articulation Index
APNL	Average Peak Noise Level
BS	British Standards
CDR	Composite Damage Risk
CL	Comfort Level
CNEL	Community Noise Equivalent Level
CNR	Composite Noise Rating
CPNL	Continuous Perceived Noise Level
DIN	German Industrial Norm (Deutsche Industrie Norm)
DME	Distance Measuring Equipment
DRC	Damage Risk Contours
ECPNL	Equivalent Continuous Perceived Noise Level
EPNL	Effective Perceived Noise Level
EEG	Electroencephalogram
EMG	Electromyogram
ENG	Electronystagmograph
ENI	Environmental Noise Index
EPNDB	Effective Perceived Noise
FSTC	Field Sound Transmission Class
GNL	General Noise Level
HL	Hearing Level
HNL	Hourly Noise Level
Hz	Hertz
ICE	Internal Combustion Engine
IDL	Intelligibility Disturbance Level

Addendum: DBA, Decibels, A-Weighted.

ILS	Instrument Landing System
INR	Impact Noise Rating
IPNL	Integrated Perceived Noise Level Loudness Level
LL	Loudness Level
LOA	Level of Optimum Articulation
MAT	Minimal Aversion Threshold
MEL	Mean Energy Level
MPL	Multiple Pure Tones
NAC	Noise Abatement Climb
NC	Noise Criterion
NIC	Noise Isolation Class
NIPTS	Noise-Induced Permanent Threshold Shift
NNI	Noise Number Index
NPL	Noise Pollution Level
NR	Noise Rating
NRC	Noise Reduction Coefficient
PNdB	Perceived Noise
PNL	Perceived Noise Level
PSD	Power Spectral Density
PSP	Comparison Peak Overpressure
PTS	Permanent Threshold Shift
PWL	Sound Power Level
RECAT	Regulatory Effects on the Costs of Automative Transportation
REIL	Runway End Indicator Lights
REM	Rapid Eye Movement
RMS	Root Mean Square
ROPS	Roll-over Protective Structures
RRL	Road Research Laboratory

Addendum: PSIL, Preferred Speech Inteference Level

RT	Reverberation Time
SAE	Statistical Energy Analysis
SENEL	Single Event Noise Exposure Level
SFC	Space Flight Center
SIL	Speech Interference Level
SIN	Spatially Incoherent Noise
SPL	Sound Pressure Level
SST	Supersonic Transport
STC	Sound Transmission Class
STL	Sound Transmission Loss
STOL	Short Take-off and Landing
TACV	Tracked Air Cushion Vehicles
TL	Transmission Loss
TLV	Threshold Limit Value
TNI	Traffic Noise Index
TPU	Transmission Preference Unit
TTS	Temporary Threshold Shift
UAA	Useful Auditory Area in Noise
VASI	Visual Approach Slope Indicator
VTOL	Vertical Take-off and Landing
V/STOL	Vertical Short Take-off and Landing
WECPNL	Weighted Equipment Continuous Perceived Noise Level